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THE GROSS EARNINGS OF 151 RAILWAYS operating 81,799 miles of road for the month of June, according to statistics collected by the *Financial Chronicle*, are $33,796,874, an increase of $2,629,291 or 8½% over the corresponding month of 1889. This rate of increase is the smallest of any month of the current year, being 0.63% less than that of March, the next lowest, and 5.35% less than that of May, which is the highest for the ye ar. The Southern roads show the largest general increase, with exceptionally large gains in two or three cases. The Southwestern roads, which have heretofore been first in the rate of increase, have fallen to second place. In this group the Atchison, Topeka & Santa Fé system shows heavy gains as heretofore. In the Northwest the Great Northern and the Wisconsin Central show large gains. The Chicago, Milwaukee & St. Paul shows a decrease of $57,704 and two or three other lines show smaller decreases For the Eastern roads the New York Central, the Grand Trunk and the Wabash show large decreases, but otherwise the showing is very favorable. This generally unfavorable exhibition of earnings, compared with the other months of the year, is the effect of the decreased volume of traffic accompanying the month of June and special causes affecting the earnings of separate lines.

RAILWAY EARNINGS FOR THE HALF YEAR ending June 30, according to the figures of the same authority, are very satisfactory. The record covers 146 roads, which show gross earnings of $216,641,296, an increase of $23,163,927 or 12% over the corresponding period of last year. Only 15 roads show a decrease, and the aggregate for these 15 is very small. Of the roads showing increases the Atchison heads the list with a gain of $2,920,626, and this exclusive of the St. Louis & San Francisco lines. The Michigan, Lake Shore & Southern shows a gain of $1,079,071, and the Chesapeake & Ohio and the New York Central show gains of nearly $1,000,000 each, and 20 other roads show increases of over $300,000. This improvement in earnings was in progress through the entire 6 months and indicates a very favorable condition of the transportation business.

THE TRAIN STAFF SYSTEM OF TRAIN OPERATION, which is now extensively used on single track railways in England, is to be adopted for some of the branches of the New York, New Haven & Hartford system, according to press reports. As a preventive of the frequent collisions which occur on crowded roads under the train order system, the train staff, especially in its improved forms, illustrated in ENGINEERING NEWS of March 29, 1890, is second only to the block system, a form of which it really is.

DISTANT SIGNALS for protecting facing point switches or the Erie Ry. must have hereafter green semaphore blades with fish-tail ends in place of the present square form. At night such signals must show a green light. All trains passing such a distant signal when at danger must be under full control, as the horizontal position indicates the switch is open.

RAILWAY TRACKS WITHIN CHICAGO'S CITY LIMITS have a total length of 1,090.82 miles, and the total area of ground occupied by railway companies is 3,843 acres.

THE WEST END RY. CO. is making good progress in its work of equipping Boston's street railway lines for electric traction. The system when completed will have a total extent of over 250 miles, covering a territory nearly 100 sq. miles in extent. The new rails weigh 74 lbs. per yd., and are laid on stringers resting on cross-ties. Up to date the company has laid about 100 miles of this track, 52 of which have been laid during the present year. About 800 men are now engaged in the work of track reconstruction.

The central power station for operating this system will be located on the site of the old Hinkley Locomotive Works. The foundations will be of heavy masonry resting on piles. The chimney will be 250 ft. high, 27 ft. 8 ins. outside diameter at the base and 17 ft. at the top. About 30 ft. have now been completed. Power will be furnished by 13 triple-expansion Reynolds-Corliss engines, each of 1,750 H. P. Each engine will run four 300 H. P. dynamos, or a total 15,600 electrical H. P.

Another central station of about 9,000 H. P. will be located in East Cambridge at the works of the New England Glass Co., which have been purchased by the company. The temporary stations erected to furnish power for the lines now in operation while the new lines are being erected are of no small capacity. On the night of July 4, when the great crowd which witnessed the fireworks on the Common was riding home the ampère meters showed a total of about 3,900 H. P. generated at the central station.

PLANS FOR THE PARIS UNDERGROUND RAILWAY are being prepared by M. BOUTILIER, Professor at the Ecole des Ponts et Chausees. The application for the concession was made by M. EIFFEL in April. A belt line 11 kilometers in length is at present contemplated.

A SHIP RAILWAY BETWEEN GEORGIAN BAY AND TORONTO is under discussion. It will be 66 miles long, and shorten the route between Chicago and Toronto by some 600 miles. Messrs. THOMAS C. KEEFER, of Ottawa, KIVAS TULLY and JOSEPH BLAKELEY, of Toronto, are connected with the project.

THE WORST ACCIDENT of the week occurred on July 9 at Sibley, Ark., 4 miles west of Memphis, Tenn., and was a head collision between a passenger train of the Little Rock & Memphis Ry. and a freight train on the Kansas City, Fort Scott & Memphis R. R. Four were killed and a dozen were seriously injured.——Another disastrous head collision occurred on the Louisville, New Albany & Chicago Ry. on July 14, near Smithville. Ind., between a local freight and an accommodation train.

A BRIDGE ACCIDENT occurred on the Texas & Pacific, three miles south of Fort Worth. A broken wheel derailed a freight train just as it approached the bridge, and the structure went down with 13 cars.——A wooden bridge on the Chicago, Burlington & Quincy, 16 miles east of Galesburg, Ill., was burned July 9.——A 2,500 ft. snowshed on the Union Pacific, near Evanston, Utah, has been burned, and will be replaced by a snow fence.——At Halifax, Nova Scotia, on July 11, the landing stage at a steamer dock sank by the slipping of a chain, sending a crowd of several hundred people into the water. About a dozen were drowned.

A TERRIBLE EXPLOSION, due to petroleum vapors, took place July 11 on the *Tioga*, one of the Union Steamboat Co's. vessels lying at Chicago. In one of the compartments of the hold were 200 barrels of refined oil. It is probable that this was of a low grade, and gave out a considerable amount of gas in the heat of the hold. The gas that is given off, being heavier than air, settled in the hold and is supposed to have been exploded by bringing a light into its neighborhood. What gives additional force to this explanation is the fact that a second explosion directly caused by the gas has occurred. The two explosions have together resulted in the death of 15 men and the severe injury of 28.

COLLISIONS are getting to be disgracefully common accidents on American railways. If any one doubts this statement, we beg leave to call his attention to the following brief list of collisions of which we have received news since the reports for last week's issue were closed:

Besides the disasters noted above, two collisions have occurred on the Norfolk & Western; one (at a grade crossing) between trains of the Port Royal & Augusta and the Charleston & Savannah; one on the Chesapeake & Ohio, July 14, killing two men; one (also at a grade crossing) between trains of the West Shore and Western New York & Pennsylvania, killing two men; one on the Baltimore & Ohio at Ogden station, Md.; one on the Georgia Pacific, near Temple, Ga., resulting in the death of two men; one on the Atchison, Topeka & Santa Fe, at Dodge City, killing two men; [one on the Baltimore & Ohio Southwestern, near Oakley, O., seriously injuring five; one at New Providence, Ind., July 12; one on the Nypano, near Ashland, O., July 15; one near Pratt Mines, Ala., July 10; and one at Chillicothe, O., July 15, killing one and fatally injuring two. Practically all the above disasters must be said to be due to the system of operating trains by telegraphic orders, a system which, however good service it has done in the past, is evidently breaking down under the steady growth of traffic, and must ere long give way everywhere to safer and more modern systems.

A DISASTROUS CYCLONE passed near St. Paul, Minn., July 13. At Lake Gervais, a suburban resort, 8 were killed and a large number were injured. Three hours later a storm burst with great force on Lake Pepin, a broad expanse of the Mississippi River 50 miles south of St. Paul, and capsized a heavily-loaded excursion steamer. Over 100 were drowned. As may be seen by the map in our issue of April 5, this fatal cyclone, as well as the recent one at Fargo, Dak., was outside what is generally supposed to be the tornado district, and their severity is therefore the more remarkable.

THE CINCINNATI WATER-WORKS seem to be going from bad to worse. Those in attendance upon the American Society of Mechanical Engineers' Convention in May will remember that the city was then on the verge of a water famine. Since then those in charge of affairs seem to have managed to just about keep pace with the breakages in their work of repairing the pumping machinery. As nearly as can be determined the facts are about these: The pumping machinery is almost all of antiquated type, designed in the days when it was thought to be the true mission of a water-works superintendent to distinguish himself by designing a pumping engine. These old slow, cumbrous machines have been under the care of employés appointed not because of their efficiency but because of their political pull. As a natural result they are out of repair and wholly unreliable.

Of the 7 engines at the pumping station, the *Commercial Gazette* says that 10,500,000 galls. per day, is their present utmost service. Three pumps are entirely disabled. In the MANUAL OF AMERICAN WATER-WORKS the total pumping capacity of the works is given as 73,000,000 galls. Work was begun months ago on the provision of auxiliary pumps which are still not half completed and are only adding 3,000,000 galls. a day to the above supply. There does not seem to be much prospect that the city will have a decent supply until the old machinery is sent to the junk heap and some good modern pumping engines, built by reputable firms, put in its place. Even then the muddy Ohio river water is hardly fit for washing, and an extensive filtering plant or some new source of supply are the only alternatives if a decent supply is to be furnished

Just at present, however, the great demand is for water of any sort, pure or impure, clear or muddy.

Mr. J. J. DE KINDER, of Philadelphia, M. Am. Soc. M. E., was sent for to take charge of the works, but refused to take the place on finding that no authority would be given him to make the necessary reorganization of the department. With the Ohio River falling and the demand for water in the summer months on the increase, the outlook for Cincinnati is by no means a promising one. The citizens are arousing to the serious danger which menaces them, and the Commercial Club have voted $2,000 for the employment of engineer experts to locate the blame for the present condition of affairs.

LATEST NEWS FROM CINCINNATI is that the Commercial Club's committee (consisting of Messrs. CHAS. SCHIFF, JULIUS DEXTER and other prominent citizens) have engaged Messrs. G. BOUSCAREN and GEO. HORNUNG as engineer experts and E. W. KITTREDGE as prosecuting attorney to conduct the investigation and prosecution. The water famine continues nearly as bad as ever.

THE WATER-WORKS RESERVOIR AT ATLANTA recently received an addition to the contents in the shape of over 100,000 galls. of cotton seed oil and 5,000 lbs. of caustic soda. The reservoir has an area of 52 acres and a capacity of about 250,000,000 galls. The burning of some oil mills situated on a brook flowing into the reservoir let loose a deluge of oil which was carried down to the reservoir. Fortunately oil and water do not mix. The former floated on the surface in some places 1½ ins. deep, and as the supply for the filters is taken from a point 20 ft. below the surface, no oil was taken into the pumping main. At latest reports the oil was being skimmed off the water as rapidly as possible and no evidence of its presence had reached the supply main.

ROCHESTER, N. Y., is suffering from a short water supply. The Hemlock lake conduit, which has always been supposed to have a capacity of over 9,000,000 galls. per day, has now been found to supply less than 6,700,000 galls. The conduit is of 36-in. and 24-in. iron pipe, partly cast and partly wrought. The total length is nearly 20 miles and it has a total fall of 143 ft. An examination is to be made to determine whether the conduit is obstructed at any point. It seems most probable that the reduction on the flow is due to the formation of tubercules in the interior of the pipe. Engineers GEO. W. RAFTER and J. NELSON TUBBS have recommended the sinking of wells to secure an additional supply.

A COMPANY TO UTILIZE UNDERGROUND WATER for irrigation and other purposes has been organized at Pueblo, Col. The projectors claim to have discovered a point where by placing a dam on the bed rock of a valley 500 yds. wide, a flow of 1,000,000 galls. of underground water per 24 hours will be stored.

A DAM IS TO BE BUILT at Austin, Tex., on the Colorado River. Mr. JOHN BOGART, Sec. Am. Soc. C. E. is Consulting Engineer.

THE LOUISVILLE-JEFFERSONVILLE BRIDGE is rapidly progressing and will, barring accidents, be completed by Jan. 1. The Jeffersonville approach is nearly finished. The caissons are all in the river and work is well advanced on most of the piers. At Pier 3 work is in progress about 80 ft. below water, and at Piers 4 and 6 work is well advanced, the latter being out of water. About $528,000 has already been expended for the work.

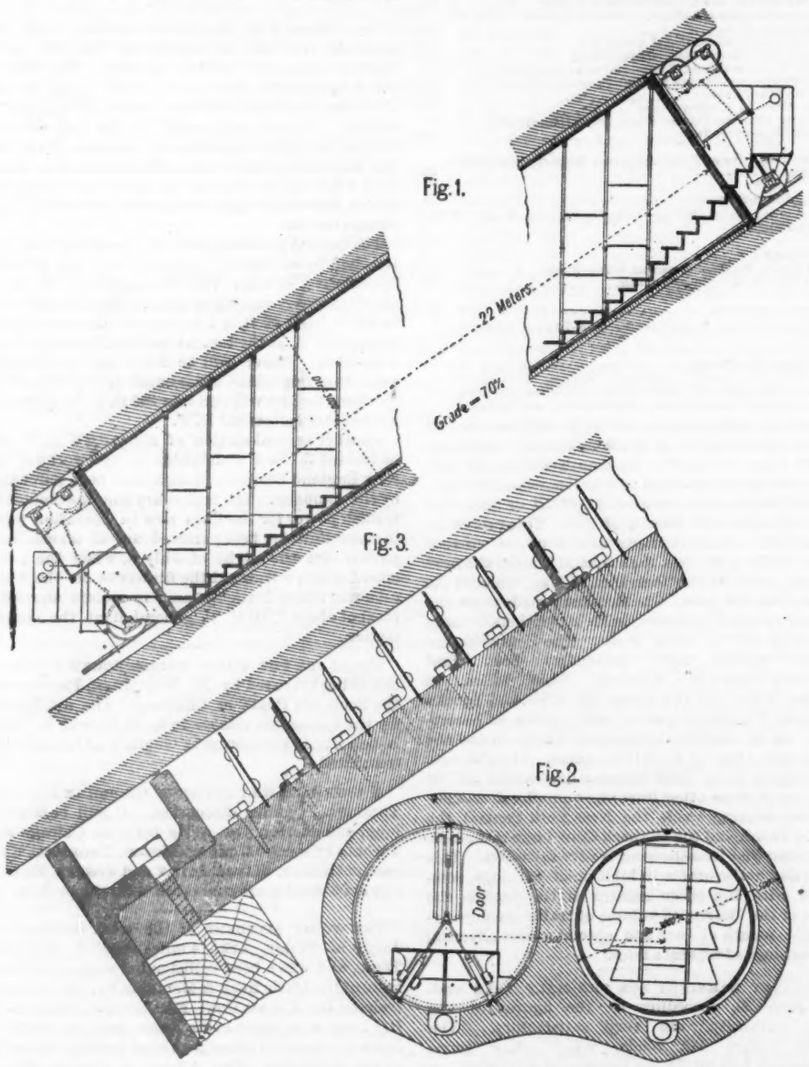
THE BROOKLYN BRIDGE BOARD OF EXPERTS organized July 15 by choosing Mr. SAMUEL SPENCER chairman, and Mr. C. W. BUCHHOLZ secretary, the remaining member being Prof. Geo. W. PLYMPTON. The Board issued the following statement:

The Board will proceed to examine such plans as have already been prepared or suggested, and are ready now to receive at the office of the Bridge Trustees such additional plans as may be presented up to Sept. 1. Due notice will be given of time and place for hearing all parties who submit plans after the necessary drawings and descriptions have been filed.

It was also announced that Secretary BUCHHOLZ would be at the office of the Bridge Trustees every Saturday to receive plans. The next meeting of the Board will be held on call of the President. It is understood that the Bridge Trustees will at once advertise for plans.

A New Jungfrau Railway Project.

In ENGINEERING NEWS for March 29, 1890, we gave a full description of the various projects for a Jungfrau railway then under discussion, and stated that the Swiss Bundesrath would probably soon decide which of the schemes should be carried out. For some reason unknown to us there was no action taken on the matter at the appointed time, and the whole subject was laid over until next September. Recently, however, we have seen the reason for this course. It seems that Oberst* LOCHER, a well-known Swiss engineer and the possessor of what our politicians would call a very healthy "pull," has devised a novel means of reaching the top of the mountain, and the delay of the government was probably due to a desire to allow the new plans to be elaborated and presented with the others. These plans of the Oberst are now the subject of much newspaper controversy in Central Europe, and we give to our readers as much of the project as has yet been published.



PROPOSED PNEUMATIC RAILWAY UP THE JUNGFRAU.

The proposed railway consists of two tunnels which lead from the valley near Lauterbrunnen to the mountain top, in a straight or slowly curved line. Each tunnel is cylindrical in section, being 9.84 ft. in diameter. The cars are also cylindrical, about 65 ft. long, and contain 50 seats. The entrances are at the ends. They are electrically lighted and have a center aisle with seats arranged as in an ordinary horse car. The wheels are not placed under the car in the usual manner, but are attached to the platforms as shown in the cuts.

Each tunnel contains three rails, two below and one above. These are to be placed in position with the utmost care and firmly attached to the masonry. After the rails are laid, the tunnel walls will be covered with a smooth layer of cement. The work will be gauged by means of a revolving templet, mounted on a car in such a way that the axis of revolution coincides with the center line of the tunnel. In this way, it is thought, a perfect cylindrical surface may be obtained.

The cylindrical car will act like a piston and be moved by means of compressed air. The weight of the car with 50 persons is estimated at 11 tons. The area of the section of the car is very nearly 75 sq. ft.; in order to keep the car at rest on a 70 per cent. incline (3,696 ft. per mile) a pressure of 7 tons, or 184 lbs. per sq. ft., must be applied to its lower end.

If the total pressure is increased by 220 lbs., the car tends to ascend; by a diminution of 220 lbs., to descend with a velocity equal to that acquired on a 10 per cent. grade on an ordinary line. It is considered certain that an ordinary car can descend a 10 per cent. grade with a steady, safe motion by careful braking, and can be readily stopped if so desired; but the difference of pressure may be made as much less as desired.

The brake shoes are placed diametrically opposite the rails, and therefore tend, when pressed against the wheels, to stop not only the revolution of the wheels but also to increase the sliding friction of the car on the rails. These brakes are worked by the conductors, and if they fail an automatic set is thrown into use.

*The Swiss title "Oberst" is given to an officer who combines certain military and civil functions, which may be best explained by imagining that an adjutant general of the army were the governor of a State, as the Oberst is of a Swiss canton.

The column of air at about 180 lbs. per sq. ft. pressure, which is sufficient to keep the car at rest, is claimed by Herr LOCHER to be one of the safest transmission agents known. A sudden drop in the pressure could only be caused by the breaking of one of the lower doors or valves, which is hardly probable in view of great strength which will be given them.

The mean speed of the cars will be 23 ft. per second, the maximum speed, limited by the automatic brakes, 26 ft. per second. This corresponds to 18 miles an hour, the average time of a European freight train.

The length of the railway will probably be about 3.728 miles, hence the trip one way will take only 15 minutes. Since the car has no heavy reciprocating parts, its motion will probably be smooth.

The pressure of the air will be obtained by means of large rotary fans, 21 ft. in diameter. Rough calculations show that about 1,971 cu. ft. of air at a pressure of 2,400 lbs. per sq. ft., or 16.5 lbs. per sq. in., must be furnished every second. This amount is to be increased by the quantity which will leak out between the car and the walls, which must be determined by experiment. In making the calculations, 2,835 cu. ft. per second have been assumed. This amount can be furnished by 2 centrifugal fans of 21 ft. diameter and making 310 revolutions a minute. At the bottom of the tunnel the weight of the column of air above the car has to be taken into account. The fans will be driven by turbines, to which they will be directly coupled, the axis of the fan and that of the turbine being in one piece.

Three such fans will deliver the necessary air into first one tunnel then the other. The pressure of the air can be regulated by altering the number of turns per minute of the turbines. The escape of the air between the car and tunnel walls will be reduced to a minimum by means of rings of iron plate, as shown in the cuts. These rings are spaced every 2 ins. and project to within an inch of the tunnel walls.

The entrances above and below will be from the sides; intermediate stations are not contemplated, although possible. At short intervals the tunnels will be connected by cross drifts. A small recess will be cut in the bottom of each tunnel for the electric conductors. The two tunnels unite into a single large one both at the upper and lower ends. The air is directed into one channel or the other by means of valves operated like those in a Siemen's regenerative furnace. All movements of fans or valves will be controlled by means of levers and suitable machinery, managed by a single man as in an ordinary interlocking switch cabin.

The details of this plan have been submitted to four of the largest engineering companies in Central Europe, and pronounced feasible in every respect.

Whether such a line would be profitable is another question. The last 1,000 ft. or so of the Jungfrau is a great needle, with nearly vertical sides, in which a tunnel would become a shaft, while for topographical reasons it appears inexpedient to even attempt to carry a tunnel up it. The upper station will probably be near a little "plateau" or shelf about 1,200 or 1,500 ft. below the summit. From this point, a grand view can be obtained, but it is no better than that which may be enjoyed from many lower points in Switzerland. A prospectus of one of the Jungfrau railways states that an easy walk of a quarter of an hour will take the tourist from the station to the summit. It may be so, but the present writer has tried to make that gentle walk three times and was unable to do so, although fresh from ascending many mountains in the Zermath and Chamounix valleys. Twice the sun thawed the snow to so great an extent that it was impossible to proceed, and the third time the wind blew with such force on the last 1,000 ft. of the ascent, the gentle pathway of the prospectus, that it was impossible to reach the summit. The latter is a mass of ice-covered rock on which not more than a score of people could stand, provided they had the requisite nerve and strength to reach the place. Our readers must not, therefore, think that they will be able to reach the summit of the Jungfrau by paying some $7 for a railway ticket. On the contrary, that part of the ascent where so many brave men have lost their lives, must still be made on foot. There is such a vast tide of travel to Switzerland however, that the railways seems very likely to be built, and to pay if built.

Machined Car Wheels.

[CONTINUED FROM PAGE 40.]

We gave last week some considerable extracts from a pamphlet recently issued by the New York Car Wheel Co., describing in general terms the processes by which, as they claim and appear to prove from records, they are enabled to turn out a vastly better article, a perfectly round and perfectly balanced wheel, with a merely nominal addition of cost. We continue these extracts below by more detailed descriptions of the ingenious methods used for boring and balancing car wheels.

These extracts, however, give but an imperfect idea of the entire precautions taken by this company to insure good wheels, which, as a whole, so far as we know, go beyond those taken by any other maker. There is no other article of manufacture known to us, on which the safety of many lives depend, in which such monstrous and habitual swindling in regard to quality has been practiced as with car wheels. The boiler-steel maker, or the locomotive tire-maker, almost invariably has some conscience, and does faithful work. It may be more or less allied to that form of gratitude which has been defined as "a lively sense of benefits to come." He may be, and no doubt often is, helped in his resolve to do good work by a lively sense of the serious consequences to his business of turning out bad work. But the fact remains that he generally does

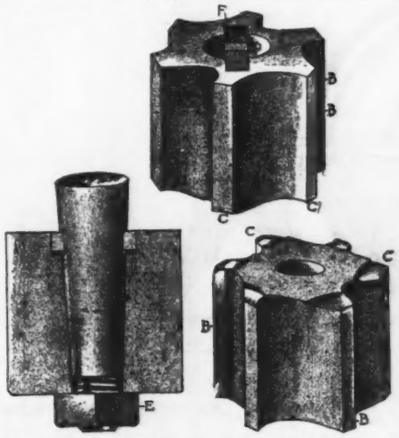


Fig. 1. Chilled Cutter for Boring Car Wheels. New York Car Wheel Co.

do good work, and we need not quarrel with the whys and wherefores which lead to so good a result.

The same whys and wherefores should to all appearance operate on the car-wheel maker, but as a matter of fact they do not, except in a very few instances. The plain truth of the matter is that there are several dozens of different car-wheel makers who manufacture on a pretty large scale, and who are prepared to take orders for "guaranteed" wheels in any quantity, and yet there certainly is not one dozen of them who take pains to turn out, or do in fact turn out, a wheel making any approach to the best which is reasonably possible, or which is really of such quality that it is either economical or safe to put them under cars. The one good quality which such wheels have is cheapness, a cheapness which is sought with the most culpable recklessness, regardless of the fact that the few dollars per car thus saved is far outweighed by the cost of the accidents, delays and frequent changes of wheels, in addition to the constant risk to life involved, which alone should forbid the use of any but the best quality of wheels.

The New York Car Wheel Co., beyond all question, deserve the credit of having done at least as much to improve the quality of modern chilled wheels as any other one concern. In partial evidence of this fact there now lies before us (unfortunately not for publication in full) a complete schedule of the tests which are made by this company for each wheel made. In outline, they may described as follows:

The first six tests are on test-blocks cast with or before each wheel. Tests 1 and 2 are for chilling qualities of the metal; test 3 for transverse strength; test 4 for tensile strength; test 5 for hardness of chill (test made by drilling and grinding in the same practical way as we have often urged as the proper one for determining the wearing qualities of rails, wheels, etc., before purchasing them); test 6 is for shrinkage and fluidity of metal, all these tests being recorded with the number combination below described of the wheel they represent.

The general tests made daily for every 50 wheels are, in outline: 1. Chemical determination of carbon, sulphur and phosphorus; 2. One wheel from every 25 tested by full "Pennsylvania" test, "to determine all this test shows"; 3. Examination by two inspectors, with records of marks, etc. All this plainly involves much trouble and expense, but the result is to give a "pedigree" for every wheel.

The "number combination," which appears on every wheel may be best shown by an example:

Nos.	Designating	
3.	Moulder's No.	Placed in particular position.
12.	Poured No.	
F 26.	Pattern No.	Letter indicates class. No. the particular pattern.
Sep. 20, 1886.	Date made.	
P. R. R.	Purchaser.	

The number combination is necessarily different on each wheel, the "poured" number being stamped on each wheel as molded. These numbers run from 1 to, say, 18 (if molder makes that number of wheels), and that with the date forms new combinations in every case, which can never be duplicated.

Each wheel is thus an individual article, and by suitable record books record of its later career as well as pedigree is preserved. Several others of the best makers in this country take something like equal pains with their wheel tests and records, but we know of none which has quite so elaborate a system. From a private letter lying before us we take the liberty of quoting some further pertinent matter in this immediate connection:

> The question may be asked: Is all this work necessary? To make an ordinary class of wheels it may not be. We are fully aware that we might abandon it, and for a time (with our present organization and men) produce results nearly as good as with it. But we could not think of such a step for a moment. As practical car wheel makers we appreciate more than any one could the value of the work. We know from long experience that no quality of material is good enough and no *intention* to use care at every stage of the work is reliable enough to produce the result we want.
>
> We can use the most expensive material and produce a wheel of the worst character; not as a rule, of course, but as no impossibility. A wheel can be made from all Salisbury iron, a mixture of the proper degree charged into the cupola, every condition in that particular being correct; but if the fuel is better than the average it does not burn as fast and the melting point is higher in the cupola and the iron hotter, the result being low chill and a safe but poor wearing wheel. If the fuel is not as good as the ordinary, the opposite results will be produced and the wheel be high chilled and possibly unsafe.
>
> The chilled car wheel, properly made, we believe to be the best and safest thing of its kind, but in no kind of manufacture, including general foundry practice, can be found the difficulties, the varying possibilities and the treacherous results that exist in making chilled wheels. To just the extent that this fact is disregarded and the precautions necessary to overcome it are relaxed, to just the same extent is the chance of broken wheels and poor service taken.
>
> We stand to-day with the record of not one wheel broken in five years out of a total of over one million wheels made in our different establishments; ready to furnish at ordinary market prices wheels mechanically perfect in every respect.

A million car wheels is an immense number to turn out; it is nearly if not quite 10 per cent. of the total now in service in the United States and Canada, and if it be true that not a single wheel of these has been reported as broken in service, as we have no reason to question, it is a quite unequaled record, even if we assume that some considerable number have broken in service without being reported. Ordinarily, some 2 per cent. of those removed, of even the best wheels, are reported as broken, and from that up to 5 per cent. or more with inferior wheels.

This output of a million wheels, it will be understood, does not refer to the Buffalo works alone, nor has nearly all this output been "machined;" *i. e.*, ground to a true circle. Nominally independent but really allied works, under the same management, are run at Detroit and Chicago, and St. Thomas and Montreal in Canada. About 300,000 wheels of this make are in use on the Canadian Pacific and the New York Central alone. About 10,000 wheels have been "machined."

The process is used for boring the wheels and for balancing them after grinding are thus described:

METHODS OF BORING CAR WHEELS.

The process of boring car wheels for the axle is a short one, yet it is of the greatest importance that it be done correctly. Common practice in doing this particular work varies from the carefully-managed shop with first-class tools and competent workmen to the worthless tools and incompetent workmen too often found.

The process of boring chilled wheels is made more difficult than similar work on ordinary cast iron by the fact that the iron in the wheel is necessarily of a hard and tough nature in strong well-chilled wheels. The difficulties encountered in the work are well known to practical railroad men.

When the wheels are difficult to bore the steel cutters lose their cutting faces very quickly and good work cannot be done with them. At times it is necessary to remove and dress the cutters for every few wheels bored. Of course the work can be done in a sort of way without the exercise of care in this particular, but the result is irregular boring and imperfect work. Safe practice and good workmanship require two cuts through a wheel hub, the first to take out the hard face of the bore and to leave clean metal for the tool taking the second cut.

The boring bars of wheel-boring mills are generally constructed to take a steel cutter having two faces from 1 to 1½ ins. wide; sometimes cutters with four cutting faces of this width are used. Attempts have been made to use cutters of chilled iron instead of steel, to save the constant expense of making and fitting the steel tools, but the brittle nature of the chilled metal prevented successful working in tools of the shape required. We have designed a form of chilled cutter or reamer (Fig. 1) possessing the following advantages: It has six cutting faces, each 4 ins. long, or 24 ins. of cutting face altogether. As will be seen, it works on the principle of a reamer, and its large bearing in the bore as the work is done prevents irregular boring, for reasons readily understood.

The heaviest work with the chilled reamer is done on the lower edges *c*, of the wings *b*. These edges can readily be sharpened on a small emery grinder when at all dull; still the correctness and perfection of the work does not depend on the cutting edges *c;* it is regulated by the cutting faces *b*, which follow through the bore, and on account of not coming in contact with the rougher and heavier part of the work (done by the edges *c*) make he bore perfect in every respect. These reamers are provided with a tapered hole *d*, which admits of their fitting over a similar shaped end fitted to the boring bar. The nut *e*, being tightened, the reamer is locked into position by small lugs on the boring bar fitting into similar recesses *f*, in the reamer. In ordinary practice from 20 to 30 wheels can be bored before the edges *c* require sharpening, which is done in a few minutes by hand on a small emery wheel, located convenient to the boring mill. From 150 to 200 wheels can be bored before the edges *b* require sharpening. This is done by placing the reamer over a suitably tapered plug fastened to the face plate of a small lathe, and doing the work with a small emery wheel attachment to the lathe generally found in machine shops.

For work to given sizes the reamers are ground to specific diameters. For general work, where it is the intention to re-bore or take a second cut, they are simply sharpened and used indiscriminately between certain sizes. For instance, on an order for 4-in. core, wheels can be bored from 4⅛ down to 4 ins., and be suitable for reboring by the user for all purposes the 4-in. core might have served. We have chilled reamers used in this manner with which we have bored with each one upward of 2,000 wheels.

With the use of these reamers on boring mills in good condition it is impossble to crowd the work of wheel boring so as to do it improperly. More work can be done than with the use of steel tools. The use of expensive steel tools and the cost of maintaining them is dispensed with. The character of work that can be done with a chilled reamer is far above that done with the ordinary boring tools, for reasons that will be readily understood by any mechanical man. We can furnish these reamers in any shape and size. They are very suitable for general machine work on pulleys, car brasses, milling machines, etc.

METHODS OF BALANCING CAR WHEELS.

After many trials of different devices for and methods of balancing chilled wheels the following was adopted:

In the manufacture of each wheel small lugs are cast upon the plate, preferably between the brackets or arms on the flange side. They may be cast at any other point on the wheel. Each lug has a ¾-in. tapered hole formed with a core in the usual manner.

Figs. 2 and 3 show the device used for testing wheels for balance. *A A* are parallel bars supported by brackets. *B B* are bars with upper surface beveled down at one end to allow the wheel with mandrel inserted to be readily placed upon them. *C C* is the expanding mandrel which is placed in the bore of wheel and tightened by means of hand wheel, *D*. The lever, *a*, fits neatly over one end of the mandrel and may be secured in any position by the thumb screw, *b*.

After the wheel is bored and ground the expanding mandrel is inserted and the keys expanded by turning the hand wheel. The wheel is then rolled between the parallel ways and supported by the projecting ends of the mandrel bearing upon them. The heaviest part of the wheel is at once located in the usual manner and marked. The lever, *a*, is turned in line with the mark and the thumb-screw, *b*, tightened to secure the lever in this position. The wheel is then turned so that the lever stands horizontally and in line with the point at which weights must be added. The slide, *c*, is adjusted at the point of diameter where the balancing weights are to be attached. Marked weights are then placed upon the slide, *c*, and the exact weight necessary to balance is ascertained. Balancing blocks of suitable shape are made as per Fig. 4. These blocks are cast of different weights, indicated by figures cast upon them, and are provided with a recess to fit over the lug, *d*, and a cored hole, *e*, through which a rivet may be passed. A block of proper weight is placed over lug, *d*, at the proper point, and a ¾-in. rivet with heated end is passed through the block and enters the tapered recess in the lug, *d*. The rivet is driven home, the heated end upset and the balancing block is securely fastened in place. When the blocks are placed between the brackets or arms they are out of the way and can be firmly secured and held in position. It will be noted that the important feature of this method of securing the balancing blocks is that nothing is done to impair the strength of the wheel in attaching them. No holes are bored through the plate from which cracks may start when severe strains are put on the wheels in service.

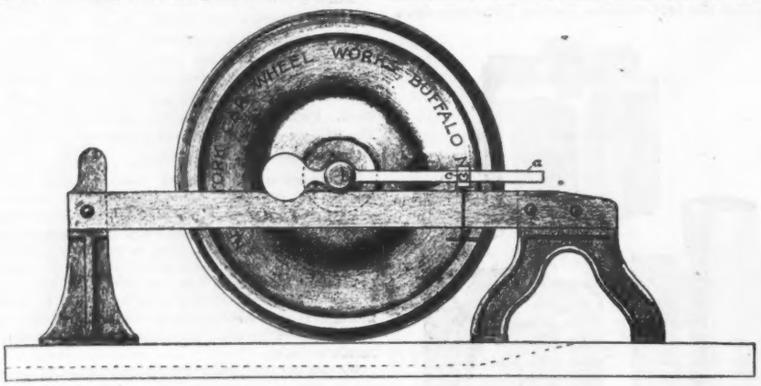


FIG. 2.

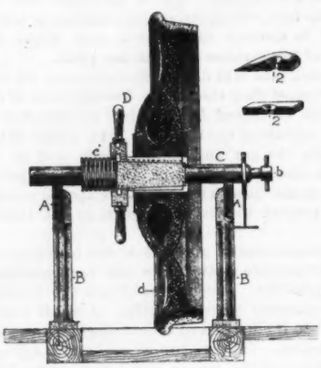


FIG. 3.

DEVICE FOR TESTING AND BALANCING CAR WHEELS. NEW YORK CAR WHEEL CO.

New York City's Water Supply.

The formal opening of the new Croton Aqueduct on July 15 was a very informal affair. The gates at 135th St. were opened by Chief Engineer FTELEY and a flow of about 1,500,000 galls. per hour came pouring into the Central Park reservoir, which is being filled for the first time since 1875. No speeches dignified the event, and the only formal recognition of the completion by an official body was a resolution adopted by the Aqueduct Commission congratulating the people of the city on the "virtual fruition of an enterprise of such incalculable magnitude and merit."

The completion of the Aqueduct places New York beyond the fear of a water famine, except in the event of an extremely dry season, when the supply from the Croton watershed will be insufficient for the city's need. The completion of the several reservoirs, now under construction, however, with a total storage capacity of 21,000,000,000 galls., will ensure the city an ample supply for a long time to come.

Although we have published the same matter in preceding volumes, we give the following brief summary of data concerning the old Croton aqueduct and the new conduit just completed.

The project for a supply from the Croton watershed was first agitated in 1831. DE WITT CLINTON was employed as an engineer in 1832 by the Common Council, and reported in favor of that source of supply. He favored an open aqueduct along the hill of the Hudson and Croton rivers, crossing the Harlem by a viaduct 138 ft. high and 1,000 ft. long. The cost of the whole he set at $2,500,000.

The plans for the work were further elaborated by DAVID B. DOUGLAS, who was Chief Engineer until 1836, when he was succeeded by JOHN B. JERVIS. The aqueduct was completed and the first water passed through it on July 4, 1842. Originally planned to deliver 30,000,000 galls. per day, its capacity was gradually increased until at completion it could safely carry 60,000,000 to 72,000,000 galls. Since the demand for more water has become pressing, it has been found possible to operate the aqueduct under pressure, and 110,000,000 to 120,000,000 galls. per day have been passed through it.

The old aqueduct is of masonry, brick lined, of 8.64 ft. vertical height with cross-sectional area of 53.34 sq. ft. Top of masonry is 4 ft. underground. It is 38.1 miles in length from the Croton dam to the Central Park reservoir, and has a total fall of 43.7 ft., ordinary grade being 1.1088 ft. per mile. The masonry was built on dry stone foundation, which settled unevenly, causing longitudinal cracks. From 1883 to 1889 the total length of these cracks repaired was 34,271 ft. The total cost of the old Croton supply, including, of course, the distribution system in New York, was $35,332,948. The cost of the aqueduct, the Croton dam and the Central Park and Forty-second St. reservoirs was $9,000,000.

Agitation for an additional supply of water began in 1858, but not much interest was taken in the matter until the great droughts of 1869 and 1870. In 1884 the auxiliary supply from the Bronx River was introduced. In 1883 the act providing for the construction of the new Croton aqueduct was passed by the Legislature, and on Dec. 20, 1884, ground was broken for its construction. The total cost of the work has been as follows:

Vouchers and pay rolls	$2,550,200.79
Contracts and agreements	19,462,069.65
Land and land damages	52,726.39
Commissioners of Appraisal	1,496,976.79
Balance due Comptroller	3,943.17
Total	$23,558,030.45

From a report of Chief Engineer FTELEY to Consulting Engineer CHAS. S. HASWELL, we extract the following:

The new Croton Aqueduct starts from the present Croton Lake, 350 ft. above the dam, and follows a general southerly course through Westchester Co. and the Twenty-fourth Ward of New York, to a point 7,000 ft. north of Jerome Park, with a uniform inclination of 0.7 ft

per mile, its general form being that of a horseshoe with curved invert, 13.53 ft. high and 13.6 ft. wide, and the estimated capacity being 318,000,000 galls. per 24 hours. From that point, where it is contemplated to build a large distributing reservoir for the supply of the annexed district, the end at 135th St. and Tenth Ave., the capacity is reduced to 250,000,000 galls. for 24 hours, and the aqueduct which is to work under pressure is circular in form, with various inclinations, and with a diameter of 12 ft. 2 in., the portion under the Harlem River being 10.5 ft.

From 135th St. start twelve 48-in. pipes, four of which are to be connected with the old aqueduct, four are connected with the present city distribution at various points, and four are laid along Convent Avenue, Ninth Avenue, Eighth Avenue, and through Central Park, with their ends at the large reservoir in the Park.

The working capacity of the pipes, like the lower part of the aqueduct, is 250,000,000 galls. in 24 hours.

The aqueduct is mostly in tunnel, except at four points, where it comes to the surface, and can be emptied through gates into Pocantico River, Sawmill River, Tibbitt's Brook, and Harlem River, respectively.

The flow in the aqueduct is controlled by batteries of gates, protected by substantial gatehouses at Croton Dam, at 135th St. and Tenth Ave., and at the Central Park reservoir, respectively.

The tunnel proper is 29.63 miles in length. The aqueduct in open trench is 1.12 miles. The length of the pipes which reach Central Park reservoir is 12,516 ft., 2.37 miles. The tunnel under Harlem River is 307 ft. below tide. The entire length of the aqueduct, exclusive of the pipe system, is 30.75 miles. The capacity of the large reservoir at Central Park is reported to be 1,000,000,000 galls.

The total number of shafts excavated for the construction of the aqueduct is 42, the depth varying from 22 to 420 ft. Twenty-three are left open to the surface for the purpose of examination and repairs.

The source of supply for the new aqueduct is, as for the present structure, the watershed of Croton River, which is expected to supply in an extremely dry year, with proper storage, 250,000,000 galls. per day. The present storage system includes Croton Lake, Boyd's Corners Reservoir, the Middle Branch Reservoir of the Croton Valley, and several natural lakes, with a total capacity of over 10,000,000,000 galls.

In connection with the new aqueduct three dams are now being built:

Sodam Dam, extreme depth of water 67 ft., and Bog Brook Dam (connected with the latter by a tunnel), extreme depth of water 60 ft. Estimated capacity of joint reservoirs, 8,000,000,000 galls.

Titicus Dam, extreme depth of water 104 ft. Estimated capacity of reservoir, 6,000,000,000 galls.

Amawalk Dam (now being built by the Department of Public Works), extreme depth of water 90 ft. Reservoir capacity, 7,000,000,000 galls.

The construction of a dam at Carmel 63 ft. high, with a reservoir of 8,000,000,000 galls., is contemplated, and other reservoirs are to be built in the future.

It is also contemplated to build a dam on the main stream below the present Croton Dam. At Quaker Bridge, the location reported on for that structure, the dam would be 178 ft. high above the bed of the stream and 265 ft. above the bed rock, with a storage capacity of 32,000,000,000 galls.

The Winner Bridge at Kansas City, Mo.

[WITH INSET.]

In our issue of March 15, 1890, we gave some account of the new bridge now being constructed at Kansas City, Mo., over the Missouri River, by the Kansas City Terminal Railway & Bridge Co., and a double inset sheet showing the working drawings, strain computations, etc., for one of the 283 ft. trusses. Our inset this week shows the strain diagram and ordering sheet for one of the 423 ft. trusses. There are 4 spans of this length in the structure, all of which are of the design shown on the inset sheet.

The accompanying cut, Fig. 1, shows a profile of the six river spans of the bridge with their supporting piers. Five of the piers, the three located in the river and those on each bank, have been put down by the pneumatic process. As may be seen on the profile, the deepest caisson rests in bed rock 129.75 ft. below the bottom line of coping, 87.23 ft. below high water mark, and 78. 33 ft. below the bed of the river. The four other piers sunk by the pneumatic process are founded at a depth almost equal to this. The contractor for the piers was the Henry L. Hopkins Bridge Co., of Kansas City. Work was begun Oct. 21, 1889, and on June 21, 1890, 8 months afterward, the last one of the piers was landed in bed rock. During that time there were put into the work 1,700,000 ft. B. M. of timber, 270,000 lbs. iron, and 6,500 cu. yds. concrete in the caissons and cribs and 6,800 cu. yds. masonry in the piers. Each caisson was sunk through

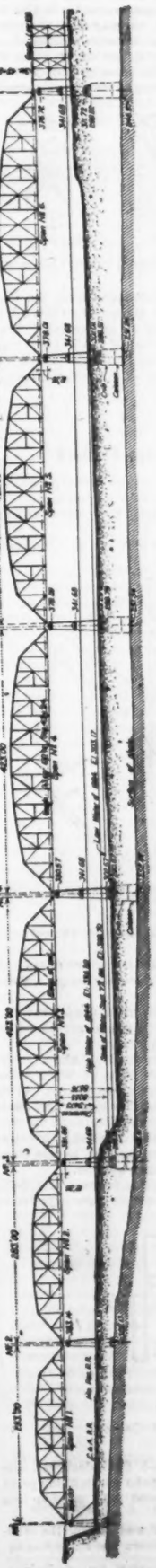


FIG. 1.—PROFILE OF MISSOURI RIVER BRIDGE, KANSAS CITY, MO.

5 to 12 ft. of boulders and from 45 to nearly 80 ft. below the surface of the ground. The masonry stone was furnished by Rettiger Bros. & Co., and is of crystalline limestone (approaching granite in hardness and toughness) to a point above the ice line. From there to the copings "Strong City" limestone was used.

The masonry was laid with Flemish bond throughout. Imported Portland cement was used until high water line was reached. Above this Louisville cement, "Queen City Star" brand was used in frosty weather and "Black Diamond" brand in warm weather. Plans were furnished by the engineer's office giving complete dimensions for every stone used, thus ensuring uniform and perfect bond. The courses are 2 ft. 10 ins. in thickness up to the belt courses, then gradually decreasing in thickness to 2 ft. 2 in. under the copings. The entire substructure will be finished by Aug. 15.

The instructions to the engineering department were that the very best class of work was to be done throughout, without regard to expense. As may be inferred from the above, these orders have been carried out to the letter. Considering the class of work done and the difficulties encountered, the time occupied in sinking the piers is surprisingly small, and both contractors and engineers deserve much credit for the rapid work.

The principal novelties of the bridge, however, are in the superstructure, designed by Mr. FRANK D. MOORE, Chief Engineer of the Kansas City Bridge and Terminal Railway Co. The principal gains which Mr. MOORE claims to have made by his novel design are the symmetry of the trusses and the avoidance of all ambiguity in the division of strains. Also in the end panels he avoids both the old error of slight inclination in the end posts, which does not give sufficient metal in the bottom chord to transmit the compression stresses due to wind pressure, as well as the recent extreme of low ends, approaching the old "bow string" girder in design, and having a tendency to similar weaknesses.

The superstructure is of open hearth steel, from 60,000 to 64,000 lbs. ultimate tensile strength. The total weight of steel in the superstructure is set at 8,500,000 lbs.

Our inset of March 15 showed the general details of the bridge, such as the floor beams, hand railing,

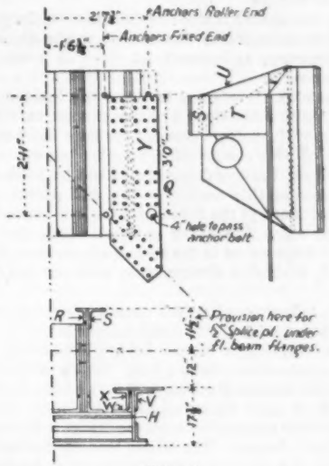


FIG. 2.

Add to each shoe of 423 ft. span:
Plate Y, 16 ins. x 5-8 ins.
Angles X, W, U, and S each 6 ins. x 6 ins. x 7-16 in.,
Angle R, 3 1-2 ins. x 3 1-2 ins. x 3-8 in.
Extend outer rib plate V of shoe and add outside plate T, 10 ins. x 1-2 in. x 25 ins. each side. Make plate H 15 1-2 ins. x 1-2 in. (instead of 13 ins. x 1-2 in.) x 50 ins. and slot it to clear lateral angle.
Add two angles 6 ins. x 6 ins. x 5-8 in. for transverse strut connecting at Q.

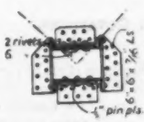


FIG. 3.

Use 6 ins. x 6 ins. x 7-16 in. angles on foot of hangers b, c, d and post e. On other hangers and posts 4 ins. x 6 ins. x 3-8 ins. as for 238 ft. span. The 1-2 in. pin plate in hangers b, c and d of of 423 ft. span and in c of 283 ft. span extend from bottom of channels to floor-beam connection.

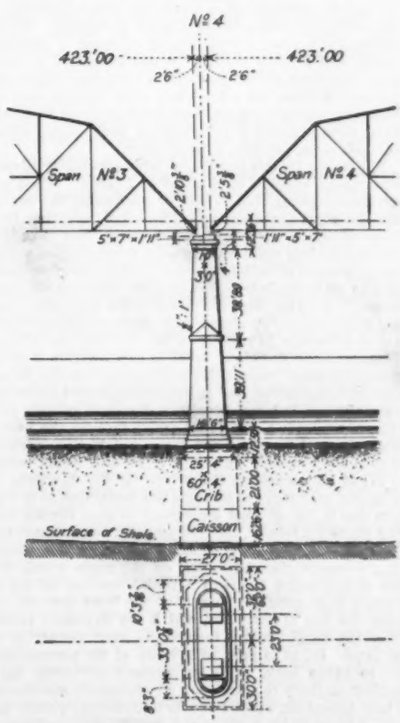


FIG. 4.

Plan and Elevation of Pier No. 4.

flooring and screens, etc., which are all the same throughout the bridge. The inset of the current week shows only the details of the 423 ft. span. The "Sheet No. 17," referred to several times in the notes upon the drawing published this week, is the sheet published with our issue of March 15. Among the

general details, one which appears especially commendable is the placing of the floor beams above the bottom chord, thus avoiding the use of floor beam hangers and making the bridge stiffer against lateral strains.

An interesting feature of the sheets is the graphical determination of the stresses made directly on the drawing, and preserved there as a matter of reference.

Sheet No. 21, referred to upon the inset sheet, is principally a description of the change in the end panels of the bottom chord, 4 eye-bars being used in place of the compression member shown on the drawing. Various dimensions have to be changed of course, on this account. The end panels of the bottom chord of the 283-ft. trusses are altered in a similar way. The other changes which this sheet calls for are noted in the accompanying cuts, Figs. 2 and 3, a similar change being made on the 283-ft. span.

Fig. 4 shows a plan and elevation of one of the river piers, with the crib and caisson below it.

The total length of the bridge is 7,633.5 ft. The truss spans shown have a total length of 2,283.5 ft.; the south approach girder is 36 ft., and the north approach is 5,254 ft. in length. The belt railway operated in connection with the bridge will be about 12 miles in length. The bridge is located about five-eighths of a mile above the Hannibal & St. Joseph railway bridge. It will connect Kansas City with the suburb of Harlem, and will afford an entrance to Kansas City for several important railway lines.

The officers of the company are: W. E. WINNER, President; Mr. FRANK D MOORE, Chief Engineer; and Mr. WM. F. WAAG, Chief Asst. Engineer.

A Use for Inertia in Shaft Governors.*

It seems to be demonstrable that inertia in shaft governors, usually a disturbing element, can be and is made the reverse, even to performing the functions of a dashpot. To one having some experience with shaft governors, it would at first appear singular that certain governors should be capable of close regulation without introducing an oscillatory action, fatal to good governing. With a flyweight moving a considerable distance, a moderate speed, and friction reduced to insignificance, it would seem that were any efforts made toward close regulation, all the conditions for a first-class revolving trip hammer would be present; and yet these governors run smoothly, even when adjusted very nearly to isochronism, within one-half of one per cent, in some cases.

The reason for this steadiness under apparently adverse circumstances seems to be about as follows: When any governor is engaged in its task of controlling the engine, the flyweight travels at a variable speed, resulting from its revolving in a circle of variable size; this change in velocity is often quite considerable, depending, of course, on the amount of radial movement and the rotative speed; to take an example from the Straight Line engine—a flyweight is 16 7-8 ins. from the center of the shaft when "in," and 20¼ ins. when "out," making at 220 revolutions per minute, a difference in velocity of 194 ft. 4 ins. per minute. Whenever the flyweight takes a new position it must change its speed—must either move faster or slower, be accelerated or retarded, and either absorb or give out power—somewhere. This resistance to a change in velocity acts at right angles to a radial line, drawn through the center of gravity of the weight, and if the weight were pivoted so as to move radially, as in Fig. 1, the only result would be to put a pressure on the pivot. If the flyweight is pivotedso as to move at an angle to a radial line, as in Fig. 2, so that in its outward movement it goes toward the way the wheel rotates, then the outward movement of the flyweight will be opposed, to some extent, by this resistance to acceleration, depending on the angle which the line of movement forms to a radial line—or, to put it another way—upon the length of the lever arm *ab*, *ca* being the line of resistance, and *b* the flyweight pivot. When the weight moves toward the shaft, the action is the same. It has to part with some of its momentum, and so hangs back, as in its outward movement, thus making, similarly to a dash-pot, a resistance to movement in both directions, which can only be overcome quickly by a great force, or by a small one slowly; this resistance increases as the velocity of the weight, which is all which is accomplished by the ordinary dash-pot. Fig. 3 shows a fly weight pivoted so as to move at an angle to a radial line, but in the opposite direction to Fig. 181. A number of governors have been constructed on this plan, with the idea that any sudden jumping ahead would tend to leave the fly weight behind, throwing it outwardly and shutting off steam, or *vice versa*, in case of a sudden retardation of the engine; the whole scheme being to make the governor very sensitive to changes in speed. In the variable velocity of the fly weight we may find the reason why these attempts have not proved more successful. As the fly-weight starts to go "out" it has the velocity due to its distance from the shaft; being pivoted so as to swing back freely, there is nothing to give it the greater

Fig. 1. Fig. 2. Fig. 3.

Diagram Illustrating Effect of Inertia in Shaft Governors.

velocity due to its increasing distance from the shaft until it gets it all at once at the end of its movement, with a slam not at all reassuring to the designer. Then when it starts to go toward the shaft it has a high velocity, and does not part with it until it strikes bottom. Of course a dash pot will cure it, but is it good engineering to build governors that way?

*Condensed from a paper by E. J. ARMSTRONG, Syracuse, N. Y., read at the Cincinnati meeting of the American Society of Mechanical Engineers.

A Governor for Steam Engines.*

The governor, which is the subject of this paper, was designed on the basis of the following propositions:

1. A governor to be sensitive must be as free as possible of friction.

2. To be powerful the forces which are in equilibrium

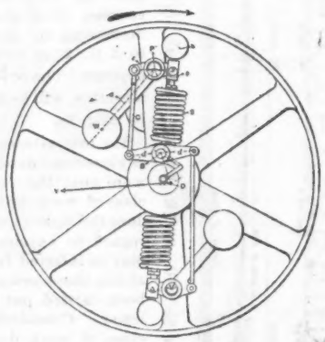


Fig. 1.—A Steam Engine Governor.

must be large compared to the resistance of the valve to be moved.

3. In order that the shaft may not be thrown out of balance by change of position of the governor weights, these weights must be symmetrical.

4. That the engine may make long runs, the joints of the governor must be so constructed as not to require oil, or be capable of lubrication while in motion.

The centrifugal governor has assumed an almost infinate variety of forms, from the fly-balls of Watt to the shaft governor of the modern high-speed engine. In all forms, however, the motive power is the centrifugal force of a weight. The centripetal force which equalizes the centrifugal force of this weight has been supplied by gravity, by the pull of the main belt, by springs, by inertia rings and by the centrifugal force of other weights.

Various devices have been added to prevent or modify the "racing" of governors due to too sensitive adjustment

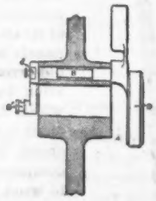


Fig. 2.—Section at Center.

or friction in the joints. Air and fluid dashpots, connected directly and through springs to the moving parts of the governor, have long been used with more or less benefit.

The lamented JOHN C. HOADLEY was among the earliest to design a shaft governor in which the valve was actuated as well as governed by the governor. He has had many followers who have profited by his experience and added their mite, until we have to-day many governors which give excellent results. In every governor the forces are in equilibrium, just as the weights on a scale beam are in balance, and whenever this equilibrium is disturbed by change of speed the parts seek new positions in which they will be again in equilibrium. The ease and therefore the promptness with which the parts move to a new position depends not upon the resistance of the valve, nor the friction of the parts which are constantly in motion relative to each other, nor to the weights, nor springs, but to the friction of the parts which were at rest relative to each other. That is, the friction of the joints of the governor proper, beginning at the eccentric disk and ending with the flying weights.

The friction of the valve, valve connections and eccentric strap, taken as a whole, is a variable quantity passing from zero to a maximum and back to zero twice in each revolution. Its mean value, however, is, or may be made, reasonably constant by the modes of lubrication in generaluse.

The friction of the joints of the governor is quite another matter.

With a constant load and steam pressure the parts assume a certain position, and do not leave that position until after a change of load or steam pressure takes place. The parts being in relative rest, they adhere to each other somewhat, and if the oil becomes gummy or scarce, as it may during a long run, they adhere quite firmly. When the change comes, the forces try to overcome this *friction of rest*, but the instant motion begins the friction is greatly reduced, and the forces which overcame the friction are unbalanced, and the weights move way past their proper position. In the effort to overcome the friction the speed has changed from the normal, and when the weights do move they move too far and allow the speed to change in the opposite direction. We then have "racing" more or less severe, according as the joints are well or poorly lubricated. It is this friction of the joints of the governor, and not the friction of the valve and connections, which prevents the use of the isochronous governor, or an adjustment of spring closely approaching isochronism.

In a successful governor for close regulation it is not only necessary that the friction of the joints be small when the engine is first started, but that it will remain small during a long run of, say, 200 or 300 hours. It is therefore very desirable that the joints be made so as to require little oil, or be capable of positive lubrication while in motion.

The governor, which is the subject of this paper, was designed in 1883, and has been applied to a number of engines with unbalanced as well as balanced valves. It is shown in Figs. 1 and 2.

A small shaft B is journaled in the hub of the fly-wheel, and is parallel to the main shaft. The eccentric, whose center is at D, is fixed to one end of the shaft B, and the cross-arm d to the other. The center of the eccentric may thus move about B, across the shaft, and produce the variable valve motion. Each end of the cross-arm d is connected by a link C to an arm c, pivoted at P. The flying weight W fixed to the arm a, also pivoted at P, tends to move outward as the speed increases. It is resisted by a weight E acting on the arm b, also pivoted at P, which moves inward when W moves outward. The spring S, whose axis is radial, also acts on arm b, and assists the weight E to urge W inward. The valve resistance V also assists the weight E. The arms a b c are all formed in one piece. The weights W and E and spring S move as nearly as possible upon radii from the center of rotation. For the purpose of reducing the friction to a minimum, the pivot P, which sustains the greatest strain, and the bearings at the ends of arms b, are made in the form of knife edges of hardened steel. They require little or no oil, and are inclosed so as not to gather dust. The joints of the links C support little strain, and are usually made simple pin connections. The eccentric being mounted on the shaft B, which has a long bearing in the hub of the fly wheel, requires little force to move it. The shaft B may beside, be oiled while the engine is running, by means of a small pipe extending from the center of the main shaft to the middle of shaft B, so that the friction here is also reduced to a very small amount. This governor is readily adapted to run in *either* direction. The forces being in equilibrium, we may way write the following equations:

$$WRN^2 Fa = ErN^2 Fb + Sb + \tfrac{1}{2} Ve. \quad (1)$$

$$WR'N'^2 Fa = Er'N'^2 Fb + S'b + \tfrac{1}{2} Ve. \quad (2)$$

In which

N = Maximum revolutions per minute.

N' = Minimum " "

R = Distance from center of weight W to center of rotation at N rev.

R' = Same at N' rev.

r = Distance from center of weight E to center of rotation at N rev.

r' = Same at N' rev.

S = Tension of spring at N rev.

S' = Tension of spr ng at N rev.

V = Resistance of valve and its parts as applied to center of eccentric D.

F = Centrifugal force of 1 lb. 1 in. from center at 1 rev.

The first side of the equations represents the moment of the centrifugal force of W about pivot P. The second side represents the moment of the centripetal forces about

*Condensed from a paper by JESSE M. SMITH, Detroit, Mich., read at the Cincinnati meeting of the American Society of Mechanical Engineers.

the same point. Suppose, now, the parts to be so chosen that the centrifugal force of the weight E, due to increase of speed, shall be just equal to the decrease of centrifugal force, due to the weight E moving nearer to the center: then

$$Er\,N^2\;F = Er'\,N'^2\;F$$
$$r\,N^2 = r'\,N'^2$$
$$r = \frac{N'^2}{N^2}\;r'$$

Subtract equation (2) from equation (1):

$$WRN^2Fa - WR'N'^2Fa = (S - S')\,b. \quad (3).$$

The weight E may evidently be so chosen that in equation (2) the tension of the spring may be zero. That is, the initial tension $S' = 0$.

From equation (3) we then get:

$$S = \frac{a}{b}\,(WRN^2F - WR'N'^2F),$$

which means that the spring has only to take up *the difference* of the centrifugal force of the weight W in its inner and outer positions, instead of the *whole* of that force, as in most governors. The spring may therefore be small and short, and still not be strained to such an extent as to fatigue the metal. A common compression spring, such as is in use under cars, has been used, and it is found simple and effective. If a spring breaks, the engine stops. The initial tension of the spring, which is what supplies the greater part of the centripetal force in most governors, is here replaced by the centrifugal force of the weight E, which force is practically constant within the range of speed variation. It may be urged that the inertia of the weight E will retard the action of the governor, and when it is in motion carry the weight too far, and thus be a detriment. On the other hand, the inertia of E and W tend to prevent the change of position of the parts, due to the rapid and great changes of the valve resistance.

The mean value of this valve resistance is practically constant, while the centrifugal forces of W and E change as the square of the revolutions; so that a pound or two increase of these weights increases enormously the strength of the governor to overcome the valve resistance. Heavy weights are therefore an advantage instead of a detriment, as they prevent the valve from controlling the governor by their inertia and produce a governor strong enough to overcome any valve resistance. Results of practice show some of the best regulations with the initial tension of the spring zero, which corresponds to the greatest value of weight E. It is evident that equation (2) may be satisfied with any values of S' and E

from $S' = O$ and E = maximum
to S' = maximum and $E = O$;

but the smaller E becomes, the larger and longer the spring must be; and it has been found in practice that a sensitive, powerful governor can best be had by giving E a considerable value.

In every centrifugal governor a change of speed is necessary to produce a change of the position of the parts, and of the valve motion. Whether this change of speed be momentary or continued, great or small, it is necessary; and the problem to be solved is how to reduce the change of speed to a minimum and still have a stable governor. In the governor under consideration, the regulation is obtained by heavy weights and light springs arranged in a peculiar manner, with friction reduced to a minimum, in contradistinction to light weights and heavy springs with artificial friction introduced to mollify the evils of real friction.

The valve motion permits a variation of cut-off from 0 to 0.7 of the stroke. A variation of speed of less than 1% between no load and 0.7 cut-off may be readily obtained in practice, and this regulation can be maintained during long continued runs. When this governor is applied to center-crank engines with valve connections outside of the fly-wheel, as is becoming quite popular, the eccentric can be dispensed with, and replaced by a wrist pin D' formed on the end of an arm extending from the cross-arm d, as shown in dotted lines at the left of Fig. 2. This will do away with the annoyance generally attending the use of eccentrics.

DISCUSSION.

F. E. IDELL: In August, 1888, I tested 3 engines in the power station of the Electric Railway station at Asbury Park, N. J, having a governor as described by Mr. Smith.

The station is equipped with four 10½ by 12-in. engines, each belted to a line shaft in the center of the room, which could be separated into two parts by throwing out a friction coupling. The engines were all set to run at 300 revolutions per minute under 80 lbs. steam pressure. The ratio of the pulleys on the engines from the line shaft was as 8 is to 9; the speed of the shaft was, therefore, 337.5 revolutions per minute. Before commencing the test the four engines were run in pairs to see if they drove the shaft at the same speed. The friction coupling was thrown out, so that each pair of engines would drive an independent shaft. A tachometer was placed on the floor at one end of the line and belted to the shaft, and the speed noted. Then the tachometer was taken to the end of the second length of shafting, bolted to it and the speed noted again. The difference in the readings was one revolution per minute, or about 0.3-10ft. During the test, readings of the tachometer were taken half hourly; the average of 61 readings for the two days was 335.5 revolutions per minute, or less than seven-tenths of 1% below the normal. The readings of the tachometer were taken at the stated intervals, without regard as to whether or not there was a sudden demand for excessive power at that time. The demand for power varied constantly. I watched the tachometer for minutes at a time, and noticed that the variation in speed lasted but a few seconds, recovering the normal speed within 15 seconds from the time any sudden demand for power was made.

Two indicator cards were taken from each engine every 20 minutes during the day and half-hourly during the evening. The speed of the engines was taken for one-half minute after each set of cards, and the record was so uniformly near to 300 revolutions per minute that this figure was used in working up the cards.

J. E. SWEET: The author of the paper says, "in order that the shaft may not be thrown out of balance by change of position by the governor weights, these weights must be symmetrical." It so happens that this statement is not true. In a single ball governor if the weight of its eccentric and its attachments balances the governor below and moves in the opposite direction on the line through the center of the shaft, it will balance it in all positions. Even were this not true, in the single cylinder engine the unbalanced weight of the reciprocating parts exceeds the weight of the governor balls perhaps as 10 to 1, so that the unbalanced single ball at its worst, would be unnoticeable in the engine. It hardly seems true that the governor can be made to work without more or less initial tension of the springs, nor does it seem as if there would be any great gain in doing so if it could. The best part of the paper is the statement "that the governor works well," which I am ready to believe (if the weight is small enough), as I am sure that there are others that work well also with fewer pieces.

E. J. ARMSTRONG: Although the statement that a governor to be sensitive must be free from friction, is almost an axiom among engine builders, the writer has much reason to question its truth. The writer has experimented with antifriction devices, and found that the governors become less steady. A small amount of friction seems to be an element of stability. This, however, is offered rather as a theory than as a statement since the writer's experiments have not extended far enough to prove to a certainty its truth.

R. H. THURSTON: It is to meet the requirements formulated in the introduction of the paper that inventors of governors have been seeking new and more perfect devices from the days of Sickels' and Corliss' inventions, and especially since the demands of the finer manufacturers, and of electrical work, have become so exacting.

I would add one more to the list, and say, 5th, that the governor may act not only promptly and powerfully but with accuracy, it must include some adjustment or some special mechanism that shall insure the quick movement of its parts into the required position, to give equilibrium, between driving power and load, instant by instant, and thus evade the ill effect of inertia in throwing the governor beyond the right point at each sudden change. There are, I think, two ways in which this result may be attained. The use of a dashpot is a familiar method of meeting these demands. In some cases, I think it may be found that the regulation of this troublesome action of inertia is effected by the friction of the valve motion itself, which pins the mechanism fast at certain points in each revolution and compels the exact adjustment of the steam distribution to but a limited extent in each of the several revolutions. How far this may prove a useful or desirable action it is impossible at present to say.

In the form of governor which is herein described, there appears to me to be a very interesting and probably useful arrangement, which, whether so intended or not, will perhaps prove to give a similar effect. The weight W is so suspended that any quick movement of the engine will jerk the whole either ahead or back, according as the load is dropped off, or thrown on, in such manner as to produce through the inertia of the weight a relative motion of W which must result in quick closing or quick opening, as the case may be.

The substitution of knife edges for pins and joints of the usual sort, is an important improvement, especially as insuring a constant and permanent sensitiveness. It is very desirable to dispense with all lubricated joints in any governor of this class. Nevertheless, where provision is made for stated lubrication the action of the original Hartwell governor, or any of the better class of its successors, can generally be made more accurate than any of the Watt governors. I should expect thoroughly good work from the governor here described.

The Manufacture of Portland Cement from Slag.

According to a carefully prepared article in *Industries*, the best cement is obtained by intimately mixing 4 parts granulated slag and about 1 part finely powdered lime. Only basic slag can be used, that from neutral or acid ovens being unavailable, even with the addition of a large amount of lime. The quantity of this latter material to be added is calculated by first finding the amount of oxygen in the slag and then taking a quantity of lime containing half as much of the element. Both substances must be thoroughly dried before mixing.

The slacked lime is usually prepared in a special converter. The lumps of quick-lime are placed in large semi-cylindrical iron receivers, which are then inserted in the converter, a cylindrical iron boiler-shell capable of being tightly closed. This converter is provided with a pressure gauge and safety valve, and is pierced by a pipe, through which the water necessary for slaking the lime is admitted. The charge is inserted in the shell, the proper amount of water added, and then the apparatus is left to complete the process automatically. The product is a finely powdered, perfectly dried slaked lime.

The granulated slag contains from 15 to 30 per cent. of water, and is dried in several ways. The most economical plan is to place it in the smaller end of a long truncated iron cone which can be slowly revolved at the same time that a current of hot air passes over the charge. With such an apparatus, 25 tons of slag can be dried in 24 hours, with an expenditure of 6 lbs. of coal per 100 lbs. of slag, and a motive power for turning the cylinders of 6 to 7 H. P.

After the granulated slag is well dried, it is ground to a fine powder in an ordinary mill. Then the lime and slag are thoroughly mixed in a revolving barrel containing a number of small metal balls, the product being the slag cement of commerce. For further details of this material we refer our readers to the issue of ENGINEERING NEWS for Dec. 7, 1889.

Adhesive Strength of Sulphur, Lead and Portland Cement for Anchoring Bolts.

During a recent experience of the writer in constructing foundations for an elevated railway solid rock was encountered so near the surface as to necessitate anchoring the foundation-bolts in it. Some more durable and economic means of accomplishing this than by the use of sulphur or lead was desired and Portland cement was suggested as being suitable.

A careful investigation failed to find any record showing the adhesive strength of cement in pounds per square inch when used this way, hence it was decided to make such experimental tests as would give reasonably positive information on this point. For this purpose 14 holes were drilled in a ledge of solid limestone, 7 of them being 1⅝ in. in diameter and 7 of them 1⅝ in. in diameter, all being 3½ ft. deep. Seven ¾ in. and seven 1 in. bolts were prepared with thread and nut on one end and plain at the other end but ragged for a length of 3½ ft. from the blank end.

Four were anchored with sulphur, four with lead and six with cement mixed neat. Half of each were ¾-in and half 1-in. bolts, and all of them were allowed to stand till the cement was two weeks old. At the expiration of this time a lever of sufficient power was rigged and all the bolts were pulled with the following results;

Sulphur: 3 bolts out of 4 developed their full strength, 16,000 and 31,000 lbs. One 1-in. bolt failed by drawing out under 12,000 lbs.

Lead: 3 bolts out of 4 developed their full strength, as above; one 1-in. bolt pulled out under 13,000 lbs.

Cement: 5 of the bolts out of 6 broke without pulling out; one 1-in. bolt began to yield in the cement at 26,000 lbs., but sustained the load a few seconds before it broke.

Whilst this experiment demonstrated the superiority of cement both as to strength and ease of application, yet it did not give the strength per square inch of area. To determine this, four specimens of limestone were prepared, each 10 ins. wide, 18 ins. long and 12 ins. thick, two of them having 1¾ in. holes and two of them 2¾ in. holes drilled in them. Into the small holes 1-in. bolts were cemented, one of them being perfectly plain round iron and the other having a thread cut on the portion which was imbedded in the cement. Into the 2¾-in. holes were cemented 2-in. bolts similarly treated, and the four specimens were allowed to stand 13 days before completing the experiment. At the end of this time they were put into a standard testing machine and pulled. The plain 1-in. bolt began to yield at 20,000 lbs., and the threaded one at 21,000 lbs. The 2-in. plain bolt began to yield at 34 000 lbs. and the threaded one at 32,000 lbs., the strain in all cases being very slowly applied. The pump was then run at a greater speed and the stones holding the 2-in. bolts split at 67 lbs. in the case of the smooth one and at 50,000 lbs. in the case of the threaded one.

It is thus seen that cement is more reliable, stronger and easier of application than either lead or sulphur, and that its resistance is from 400 to 500 lbs. per sq. in. of surface exposed. It is also a well ascertained fact that it preserves iron rather than corrodes it. The cement used throughout the experiment was an English Portland cement.—A. A. S., in *The Polytechnic* (Troy).

The Manchester, England, Steam Users' Association.

The annual report of "the Manchester Steam Users' Association for the Prevention of Steam Boiler Explosions and the Attainment of Economy in the Application of Steam," shows results from co-operation and systematic inspection which are only paralleled in this country by the Manufacturers' Mutual Fire Insurance Co., of New England, working in a somewhat different field. The Association, which was established 36 years ago, carries on a system of inspection of all boilers owned by members of the Association; and so carefully and thoroughly is the work done, that the members are thoroughly guaranteed against the danger of explosions. On Dec. 31, 1889, the association had 1,721 members, and there were 4,888 boilers in 2,385 works under its charge. This is an increase over all previous years, and over 1888 of 49 members, 50 works and 38 boilers. The total income for the year was $55,260. The total expenses were $50,119, or $10.25 per boiler inspected. During the year 9,141 visits were made by the chief engineer and inspectors, 8,963 external examinations of boilers were made, and 5,191 "internal," "flue" and "entire" examinations of boilers were made, or a total of 14,154 total examinations of boilers in all. Beside this 1,502 engines were indicated. We make the following extracts from the report:

The high number of entire examinations of boilers annually reported has been maintained, and the experience of another year, gathered from the daily work of the Association and from the facts supplied in the reports of the Board of Trade on the investigations made into the causes of steam boiler explosions, confirms the oft-expressed opinion in these reports, that were the system of periodical entire examinations of boilers carried out by this Association for more than a quarter of a century in universal application, a boiler explosion would very rarely be heard of.

The committee are gratified to be able once more to congratulate the members of the Association on the immunity from explosions which they enjoy from year to year, while outside the ranks of the Association it appears from its records that during the past year 66 steam boiler explosions occurred, killing 29 persons and injuring 57 others, in addition to 20 miscellaneous boiler explosions, killing 10 persons and injuring 30 others, making a total of 86 explosions, 39 deaths and 87 cases of personal injury.

Of the total number of explosions, 72 were investigated by the Board of Trade under the "Boiler Explosions Act, 1882," eight occurred at coal mines, which are at present excluded from the working of the said Act, one was investigated under the Merchant Shipping Act, and the remaining five were of minor character, and either escaped notice or were not considered of sufficient importance to need an inquiry.

The "Boiler Explosions Act, 1882," was carried through Parliament by the late HUGH MASON, Esq., M. P., when President of this Association, and the working of the Act has been constantly and carefully observed. The Committee believe that it has been of very great service. The Act provides for what is termed a "Preliminary Inquiry" with respect to every steam boiler explosion occurring throughout the United Kingdom, except in the case of a boiler used exclusively for domestic purposes, or in the service of Her Majesty, or on board a steamship having a certificate from the Board of Trade, or at a coal or other mine; and up to February, 1890, upwards of 375 such Preliminary Inquiries had been held. The Act also provides for a "Formal Investigation" at the discretion of the Board of Trade by means of a Court specially constituted for the purpose. Up to the same date only eight such "Formal Investigations" had been held, and in six of those cases the Board of Trade had thrown the cost of the investigations, or a portion thereof, on the parties to whose neglect the explosions were deemed to be due.

The intention of the promoters of the Act was that these "Formal Investigations" should be held *as a rule* in the case of all steam boiler explosions, and the Committee being convinced that were the rule observed the facts that would be elicited and the applications thereof that would be made would be so valuable in promoting the attainment of the final end sought by the Act, viz., the prevention of Steam Boiler Explosions, that they memorialised by deputation the President of the Board of Trade in February of this year, praying that the Act might be put into vigorous operation by increasing the number of "Formal Investigations." Since then nine additional "Formal Investigations" have been held, and in the terms of their memorial the Committee may express their belief that the full carrying out of the "Boiler Explosions Act, 1882," "will result either in rendering further legislation for the prevention of boiler explosions unnecessary, or in bringing such facts to light as will show how further legislation can best be framed."

The Hudson Tunnel Shield.

In ENGINEERING NEWS for March 15, we gave a description of the Hudson Tunnel Shield with some detail drawings. The shield is now under construction in England in the Dalmarnock Iron Works of Sir Wm. Arrol, and we are indebted to *Industries* for the accompanying cuts and description of its present appearance, which Mr. W. R. HUTTON, Resident Engineer in charge, assures us is in all essentials correct. The face of the shield is formed as a cutting edge and the horizontal shelves extending across the shield are similarly armed to pass through the material encountered. Behind the cutting edges, the shield is closed by a diaphragm of iron plate, shown in Fig. 3. In this diaphragm doors are placed which can be opened to admit the material being excavated, the pressure of compressed air preventing the admission of water. When harder and impervious material is traversed, the doors are opened and the workmen attack the face of the heading. When a sufficient quantity of material has been removed, hydraulic rams attached to the shield advance it by acting against the lining of the tunnel already completed, and a fresh section of lining is at once added.

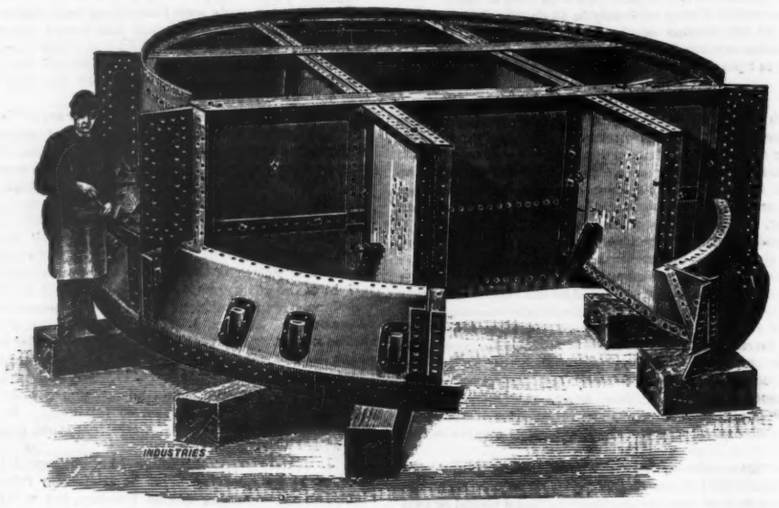


FIG. 1.—FRAME AND CUTTING EDGE OF SHIELD.

FIG. 2.—SHIELD NEARLY COMPLETED.

The external diameter of the shields is 19 ft. 11 ins., and the distance from the cutting edge to the tail of the shield 10 ft. 6 ins. The outer skin is made up of two thicknesses of ⅝-in. steel plate. The diaphragm is placed 5 ft. 8 ins. from the cutting edge, and is pierced by nine doors. There are two horizontal girders between the doors and the cutting edges; their double .5-in. webs are connected to the door plates and vertical diaphragms by 6 × 6 × .75 in. angles. The two vertical diaphragms which divide the shield similarly throughout its entire height are built by 4 × 4 × .5 in. angles and a .5-in. web. The face of the shield is thus divided by these horizontal and vertical girders into nine cells, access to each of which is gained through a door from the after compartment of the shield. The inner skin of the shield is composed of 5-in. plating, and extends from the plates forming the division of the shield carrying the doors to within 2 ft. 4 ins. of the cutting edge, and is separated from the outer skin by a distance of 1 ft. 5 ins. There are 16 diaphragms of .5-in. plates 3 ft. 2 ins. by 1 ft. 5 ins., with 4 × 4 × .5-in. angles running completely around on each side, and spaced equidistantly around the shield between the two skins, as shown in Figs. 1 and 2. The doors are 9 in number, of ⅝-in. plates; 7 are square and dished, covering openings ranging from 2 ft. 6 ins. × 2 ft. to 2 ft. 3 ins. × 1 ft. 9 ins., the 2 remaining ones being triangular, measuring 2 ft. on a side. The doors are faced at their bearing surfaces with india rubber ¼ in. thick. The ⅝-in. plates forming the vertical diaphragm are stiffened by 6 vertical girders 6.5 ins. deep, each made up of 4.5 × 3 × .5 in. angles, with a 6.5 × .5-in. top flange plate and a .5-in. web.

The 16 hydraulic cylinders for advancing the shield are placed between the two skins and spaced

equally around the circumference. They are 3 ft. 4.5 ins. long with external and internal diameters of 10.75 and 8 ins. respectively. The rams have an internal diameter of 3.5 ins., and with the cylinders have been tested up to a pressure of 2 tons per sq. in.

Paving Bricks and Brick Pavements.

BY CHAS. P. CHASE, C. E.

Most of the early brick used in this country were not of home manufacture, but came from England and Holland, being carried as ballast by sailing ships. The quality of these brick was bad, as they were far from uniform, under-burnt and of a poor composition. Of course this soon led to the manufacture of brick in the United States, but the results were not very satisfactory. The brick were burned in up-draft kilns with wood as fuel, 2 weeks not being an unusual period for burning. In 1826 the experiment of mixing coal dust with clay was tried and resulted in reducing the time of burning one-half and giving a more uniform brick. It was only 20 years ago that brick were first used to any extent for street pavements; what were known as paving brick had been on the market for some time, but their use was limited to tunnels and foundations. The brick of to-day, however, must not be judged by those of 20, or even 10, years ago, as the quality of brick has so much improved that what would bring a fair price 10 years ago is hardly marketable now.

STRENGTH OF BRICK.

A convincing evidence of this advance is shown in the tests of strength of these bricks; taking the tests as given in standard engineering books 8 or 10 years ago, we find in Trautwine the strength of brick given as 500 to 4,200 lbs. per sq. in. Now, taking recent tests, in experiments made at Watertown Arsenal, the strength ran from 5,000 to 22,000 lbs. per sq. in. In the tests on Illinois paving brick, by Professor I. O. BAKER, we find an average strength, in hard paving brick, of over 5,000 lbs. per sq. in. The average crushing strength of 10 varieties of paving brick, much used in the West, I found to be 7,150 lbs. to the sq. in. There are a number of causes which have brought about this improvement, as manner of burning, better classes of clay and a more thorough and uniform mixing of the material, resulting from the use of mixing machines.

MANUFACTURE OF PAVING BRICK.

Most of the paving brick now in use are made from fire-clay, a hydrated silicate of alumina, generally containing traces of magnesia, iron, lime and potash, which make the brick more flexible and easier to fuse. Three to four per cent. of siliceous matter renders it fusible. Lime is injurious to the brick, as it is changed to caustic lime in burning, and a small amount of moisture reaching this will cause it to slack and disintegrate the brick. A small amount of magnesia aids in producing vitrifaction. A small amount of iron is not injurious in a paving brick, but in a brick to resist high temperature 6% of iron makes it useless. Alumina (and not iron, as Mr. STEYTH says) gives elasticity to the brick, and is tough and binding, readily fusing in the presence of silica. The other constituents are impurities, and act as a flux.

The plasticity and flexibility of the clay is due greatly to the fineness of the particles, and has a direct bearing on the strength of the brick. Uniform fineness is positively necessary to obtain the best results. The clay must be in a fine powder before mixing; it is then carefully tempered and is ready to be shaped into brick. If the clay is neither dry nor fine it should be calcined and then finely ground. Of two samples of clay, one fine and one coarse, the fine clay will vitrify quicker, the stronger and harder the brick will be, and it will stand abrasion much better. In examining and breaking brick it will be found that if the clay was not properly prepared, and the brick thereby contains small pebbles or other coarse material, it will crack or spall around these, and but a slight blow will be necessary to break it. In a large number of briquettes which were tested for tensile strength it was found that when coarse material was present the break occurred *around* this material, and the strength of the briquette fell below the average. The color of different varieties of brick has nothing to do with their strength, though in some varieties vitrifaction is shown by the change in color in burning. Iron is the chief cause of this, though bituminous matter will also effect changes in colors. Another cause of lack of uniformity is the manner of burning. Many companies having good clay and first class mixing machines have failed to make a good brick because they could not be induced to give up the old-fashioned up-draft kilns. It is an impossibility to come anywhere near uniformity using one of these. Three classes of brick will be produced: soft outside brick, a fair brick in the middle courses, and brittle over-burnt ones near the arches; or, the outside brick being good, the courses near the fires are fused into one mass. With the oven or down-draft kiln, 75 to 90% of good paving brick can be produced, and the remaining 10 to 25% make excellent brick for foundations. Another improvement, which it is to be hoped will be more generally adopted in brick burning, is the substitution of oil and natural gas for wood and coal. These fuels have been used with considerable success by a number of brick companies. At Cleveland, O., a kiln of 25,000 brick are burned in 4 days using 25 burners, a saving of 3 days in time, and one man does the work of three. The Purington Kimbell Brick Company, of Chicago, use crude or waste oil after the naphtha has been extracted.

In the burning, hot oil, hot air and steam are necessary. The burners are placed in the arches and the brick are burnt in 60 hours. The saving of wood is 35%; total saving over old methods, 33⅓%. These are not paving brick, but the illustration will serve as an example of the economy of the new method. The company have no clay which would make a good paving brick, but in several places paving brick, burned by natural gas, have been a success. This would probably be a profitable line to experiment in.

The result of the burning, if properly conducted, is a semi-fused brick, really an inferior glass, due to the combination of silica, alumina and some base. The chemistry of burning is as follows: at 100° C. the water held in mechanical suspension is driven off; that held in chemical combination is driven off at a little below red heat; at a red heat the carbonates are decomposed and organic matter is consumed; at a white heat vitrifaction takes place and here the burning stops.

(To be continued.)

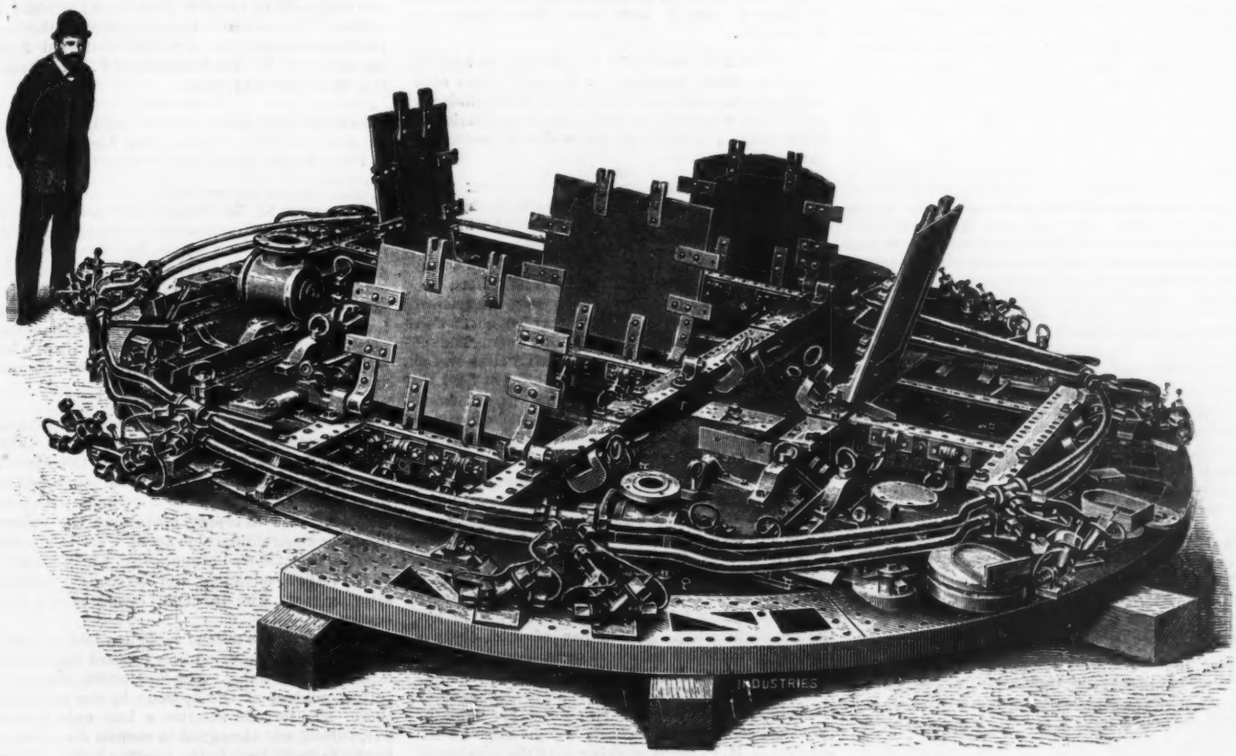


FIG. 3. DIAPHRAGM FOR SHIELD, HUDSON RIVER TUNNEL.
Sir Benjamin Baker, Engineer. Wm. Arrol & Co., Contractors.
This diaphragm goes inside the shield beneath the man shown in Fig 2.

THE LINDENTHAL NORTH RIVER BRIDGE BILL has become a law by the signature of the President. In the mean time some lawyers and lobbyists have appeared before the House Commerce Committee on behalf of the Greene bill, seeking to obtain a duplicate charter, and, according to the secretary of the company, $260,000 of stock has been subscribed for, out of a required $300,000, and 10% thereof paid in. Mr. LINDENTHAL appeared in opposition, alleging that a charter was sought for merely speculative purposes; that they specified no particular location or plan; that their State charters were invalid, and that the granting of their application might embarrass a legitimate enterprise already authorized and organized, and reasonably sure of success. There is little probability of even a favorable report from the committee on the application.

THE BUSK TUNNEL will not be built by D. Shanahan & Co., of Louisville, Ky., as we stated in our issue of June 21. Since that date, the contract, which was never fully closed, has been declared off by the above firm. Mr. B. H. BRYANT, Chief Engineer of the Colorado Midland Ry., informs us that the tunnel will be built by the Busk Tunnel Ry. Co. This line leaves the Colorado Midland Ry. a short distance east of Busk Station, and joins that line again at Ivanhoe Station. The tunnel line was located last November. Its total length is 9,350 ft. The contract has not yet been let, but it will be soon. Work will probably be finished April 1, 1892. The total length of the present line is 10.18 miles. The highest point on grade of present line is 11,528 ft. above sea level; highest point on new line, 10,948 ft. The new line saves 0.93 miles of distance, 501 ft. of elevation and 1,958 of curvature. The tunnel is through the Continental Divide; the elevation of the crest of the mountain over the tunnel is about 12,000 ft.; the elevation of the grade of the tunnel directly under the crest of the mountain is 10,872 ft.

A TUNNEL UNDER NEWTOWN CREEK, L. I., is under discussion. The bridges that span the creek are opened so often and are in such bad condition that travel is greatly impeded. It costs over $25,000 a year to operate these bridges, repairs amount to $10,000, and every new bridge costs from $60,000 to $75,000. Many members of the Board of Supervisors of Queens Co. favor a tunnel; and if the consent of the Kings Co. authorities can be obtained, it will probably be built.

THE FIRST TEST HOLE for ascertaining the thickness of the different strata of rock which will be encountered in driving the Niagara tunnel has been completed. At a depth of 142 ft. the drill left the hard gray limestone which is the surface rock and entered a hard blue slate. At 203 ft. it passed into limestone again, which prevailed to the bottom of the hole, 214 ft. from the surface.

THE SURVEYS FOR THE PENNSYLVANIA SHIP CANAL from Lake Erie to the Ohio River are finished with the exception of some supplemental surveys just authorized by the Commission. Mr. JOHN M. GOODWIN is Chief Engineer.

THE SAULT STE. MARIE CANAL during the year ending June 30, 1890, gave passage to 10,108 vessels, of which 6,806 were steam vessels propelled by screws and 2,834 were sailing vessels. The following are some of the more important items of the traffic passing through the canal:

Coal, net tons	1,894,433
Copper, net tons	36,087
Flour, barrels	2,592,736
Wheat, bushels	19,459,796
Grain, other than wheat, bushels	2,732,698
Iron ore, net tons	4,404,935
Pig iron and manufactured iron, net tons	72,163
Salt, barrels	207,762
Lumber, feet b. m	308,032,000
Unclassified freight, net tons	344,425
Number of passengers	24,125
Total registered tonnage	7,899,604
Increase over previous year	1,686,110
Total freight tonnage	8,288,580
Total registered tonnage since opening the canal in 1855	56,539,576
Total since opening new lock in 1881	38,549,853

Beside the lumber above reported, 9 rafts contaning 17,500,000 ft. of lumber were passed down the rapids.

During the calendar year of 1889 there were transported through the canal 7,516,022 net tons of freight. The average distance over which this freight was carried was 790.4 miles. The total number of mile tons was 5,940,646,352. The total cost of transportation was $8,634,246. The average cost of carrying one ton one mile was 1⅛ mills.

A SHIP CANAL FROM PHILADELPHIA TO NEW YORK is proposed by Prof. L. M. HAUPT in a recent number of *The Manufacturer*. The cross-section of the proposed water-way would be 90 ft. at the bottom with 20 ft. depth, giving a total cube to be excavated of 26,317,614 cu. yds. About 350,000 cu yds. would also have to be dredged at the terminals. The locks would be 500 ft. long, 60 ft. wide and 20 deep, with a lift of 25 ft. Upon this basis the estimate is $12,552,901, not including the cost of right of way. Inasmuch as the two cities have already excellent water communication by the open sea, it is a little difficult to see how the proposed canal could be a paying enterprise.

THE CONSTRUCTION OF A CANAL, for the passage of boats between Burlington, Wis., and Brown's Lake, is now proposed, and an engineer is to be engaged to make investigations and furnish estimates of cost. The Wind Lake Canal will be finished this fall, and it is thought that by putting a coffer dam below the Rochester mill-dam a boat can be floated over it and down the stream to Burlington.

THE CHICAGO DRAINAGE ENTERPRISE is making progress. Chief Engineer L. E. COOLEY has been authorized to employ at once a force for preliminary operations, consisting of 22 engineers, at salaries of $50 to $200 per month, and to secure an outfit for the party.

A REMARKABLE ELECTRICAL TRANSMISSION plant has recently been put down in Nevada, in the Comstock lode and Sutro tunnel. At the Nevada Mill there is a 10-ft. Pelton water wheel, supplied by a pipe line delivering water from the side of Mount Davidson under a head of 460 ft., giving 200 H. P. Here the water is caught up, delivered into two heavy iron pipes and conducted down the vertical shaft and incline of the Chollar mine to the Sutro Tunnel level, where it is again delivered to six Pelton water wheels, this time running under a head of 1,680 ft. Each of the six wheels is but 40 ins. in diameter, weighing 225 lbs.; but with a jet of water less than ⅝ in. in diameter they develop 125 H. P. each. On the same shafts, which revolve 900 times a minute, are coupled six Brush dynamos, which generate the current for the electric motors that drive the stamps in the mill above ground. The result is that, where it formerly took 312 miners' inches of water to operate 35 stamps, but 72 ins. are now required to run 60 stamps. This is the greatest head of water ever used by any wheel, and marks an era in hydraulic engineering. A solid bar of iron thrown forcibly against this jet rebounds as though it had struck against a solid body instead of a mobile fluid. The velocity of the jet, where it impinges against the buckets of the wheel, is two miles per minute, 176 ft. per second. The wheels weigh only 1.8 lb. per electric H. P. when working with the maximum head, figures which are only surpassed by the Brotherhood engines used for driving torpedoes, and possibly by the Parsons steam turbine. At the Terni steel works in Italy there is a Girard turbine using water under a head of 1,000 ft., and which we believe is the greatest head used in Europe.

PROPULSION OF BOATS BY ELECTRICITY is effectually exhibited at the Edinburgh Exhibition. On the Union canal, which skirts one side of the exhibition site, 4 launches, each 40 ft. long, 6.5 ft. wide, drawing 2 ft. of water and carrying 40 persons, are run by storage batteries. The machinery has been supplied by M. Immisch & Co., of London. The charging plant consists of an Immisch dynamo and a 25-H. P. engine, all the launches being charged at the same time, usually at night. A launch can run 10 to 15 hours on a singly charge. Details as to weight of storage batteries and time taken for charging are lacking.

THE CHICAGO SHIP BUILDING CO. laid the keel of its first vessel on July 1, a steel propellor of 2,500 tons burden for the Minnesota Steamship Co. The keel of a second vessel for the same company of the same tonnage and design as the first has since been laid. These are the first steel vessels to be built on Lake Michigan, but its proximity to the ore-producing districts leads to the belief that Chicago will yet eclipse Cleveland as a ship-building port.

THE SHIP-BUILDING PLANT OF WM. CRAMP & SONS on the Delaware River is to be extended so as to be able to turn out a much greater amount of work. The capital stock of the company has been increased to $3,500,000, and a speciality is to be made of the construction of ships of war.

A LINE OF MISSOURI RIVER STEAMBOATS has been started to ply between St. Louis and Kansas City. The boats are of 1,500 tons capacity. It is proposed to call a convention to meet at Kansas City this fall to urge upon Congress the desirability of making a large appropriation for the improvement of the river. A great trouble with the navigation of the Missouri, however, is that its current is pretty swift, and a second obstacle in the way is that shippers at Kansas City can probably get their goods to market cheaper on the whole by means of the railway.

TWO STEEL STEAMSHIPS for coal trade on the Atlantic coast are being built on Lake Huron. The boats are to be 200 ft. in length and 41 ft. beam. As the Welland canal locks are only 185 ft. in length, the boats will be taken to Buffalo and divided into halves. Each half will be towed through the canals. One boat, the *Mackinaw*, is to be delivered Aug. 1, the other Oct. 1. The builders are F. W. Wheeler & Co., West Bay City, Mich.

THE TORPEDO BOAT CUSHING made a fast run of 120 miles from New York to New London on July 11 in 4 hrs. 42 min. 25 sec., or at the rate of 25⅝ miles per hour.

DRAWINGS OF ERICSSON'S SUBMARINE TORPEDO GUN were recently submitted to the Army Ordnance Board. This was one of the last inventions of the great engineer. An important feature is that the old smooth bore muzzle loading cannon, which are now too antiquated for ordinary service, can be used for firing these submarine projectiles, with ordinary powder as the firing charge. The invention is being developed by the Ericsson Coast Defense Company, 35 Broadway, New York.

THE SIMS-EDISON ELECTRIC TORPEDO COMPANY gave an exhibition of their fish torpedo at Willet's Point on July 15. The torpedo is in two parts, one parallel to and about 6 ft. above the other, and 28 ft. long. The lower portion is a cylinder with conical ends covered with copper, containing the explosive used, the controlling cable about ⅛ in. in diameter made of fine, twisted copper wire, which is paid out as the torpedo advances, and the electric motor and steering gear. The upper part consisted of a float of copper.

In the tests, one mile of cable was laid in 2 min. 59 sec. The float was at no time exposed more than an inch above the water. The exhibition showed the perfect control of the torpedo by the operator on shore. The torpedo was run a half mile down the bay, turned and zigzagged in various directions and finally brought back to the starting point. The current used was of 1,000 volts pressure. The company is now building a 33-ft. torpedo for the United States Government.

THE HALPIN-SAVAGE TORPEDO, lately inspected by the Board of Naval Engineers, carries its own motive power in the shape of storage batteries, and only a very light wire cable is paid out, by which the operator on shore controls the steering gear. The torpedo proper has an independent means of propulsion by rocket composition which can be fired electrically. The mechanism is so arranged that when a net is hit the torpedo is disengaged, dives underneath the net, comes up and is exploded when close to the hull. The invention is certainly ingenious, but seems rather complicated for use in actual warfare.

ENDURANCE TESTS of the Maxim machine gun in Germany showed that 20,000 steel covered bullets could be fired from a single barrel before the rifling was materially injured.

THE BODY OF JOHN ERICSSON is to be taken to Sweden by the United States cruiser *Baltimore*, now serving as flagship of the North Atlantic Squadron. The *Essex*, which was at first selected to go on this mission, was deemed too insignificant a vessel for this duty, and has been ordered to the South Atlantic squadron.

PERSONALS.

Mr. W. A. SOMERS has been elected Engineer of the water department of St Paul, Minn.

Mr. J. K. SROUFE has been made Engineer of Maintenance of Way of the Kentucky Union Ry.

Mr. WILLIAM REDD, JR., has been appointed Superintendent of the Columbus Southern Ry., with headquarters at Columbus, Ga.

Mr. A. HARVEY TYSON, of Reading, Pa., M. Am. Soc. C. E., has been appointed Consulting Engineer to the Water Board, of Freehold, N. J.

Mr. W. C. PAGE has been appointed Assistant Superintendent of the Chicago, Rock Island & Pacific Ry. lines west of the Missouri River.

Mr. D. BONTICOU has been made Engineer of the Kansas City, Fort Scott & Memphis R. R. with headquarters at Kansas City, Mo.

Mr. R. N. BILLINGS, late Constructing Engineer of the Newfoundland railways, will build the electric street railways of San Antonio, Tex.

Mr. W. A. VAUGHAN has been appointed General Superintendent of the East Tennessee, Virginia & Georgia Ry., with headquarters at Knoxville, Tenn.

Mr. C. G. WILSON has been appointed Superintendent of the Iowa lines of the Chicago, Burlington & Quincy R. R., with headquarters at Burlington.

Mr. S. H. HARRINGTON has resigned his position of Mechanical Engineer of the Erie Ry. in order to accept a similar office on the Cleveland, Cincinnati, Chicago & St. Louis Ry.

Mr. RUDOLPH HERING, of New York, M. Am. Soc. C. E., is now in the Northwest examining the sewerage systems of several cities. Among others, he will report upon a system for Victoria, B. C.

Prof. J. W. SPENCER has been appointed State Geologist of Georgia. His first work will be to make a careful geological survey of the State, which will probably take six years and cost $80,000.

Mr. A. C. HIPPEY has resigned his position as Superintendent of the Altoona division of the Pennsylvania R. R. to accept the position of General Superintendent of the Norfolk & Western R. R.

Messrs. F. L. SIZER and J. S. KEERL have opened a general engineering office at Helena, Mont. Mr. SIZER graduated from the Michigan University, and has since been connected with many important mining enterprises in the Northwest. Mr. KEERL graduated from the University of Pennsylvania, and has been engaged in river and harbor work and in railway location.

Maj.-Gen. JOHN C. FREMONT, who died in New York July 13, was engaged in 1836-37 with Capt. W. G. Williams in surveying a railway line from Charleston to Cincinnati, and served as Lieutenant and Captain in the Topographical Engineers from 1838 to 1845. It was during this period of his life that he made the Western explorations by which he won the name of "Pathfinder."

MR. DANIEL BONTECOU, M. Am. Soc. C. E., has been appointed Chief Engineer of the Kansas City, Fort Scott & Memphis, Kansas City, Memphis & Birmingham, Kansas City, Clinton & Springfield, and Current River Railroads, comprising a total of about 1,200 miles. His headquarters will be at Kansas City. Mr. BONTECOU was formerly associated with Mr. WM. B. KNIGHT in the firm of KNIGHT & BONTECOU. He has had much experience in railroad work in connection with the Kansas City Belt Ry. and other companies.

NEW PUBLICATIONS.

BOOKS.

—*Experimental Electricity*, by EDWARD TREVERT, author of "Everybody's Hand Book of Electricity" and "How to Make Electric Batteries at Home." 5 x 7 ins. Cloth bound. 164 pp. Illustrated. Bubier Publishing Co., Lynn, Mass.

Probably not many readers of ENGINEERING NEWS have the leisure for the sort of amateur work to which this little book is devoted; but those who do enjoy pottering over experiments and home-made instruments will find much to aid and interest them in it. The author tells in simple language how to make electric batteries, bells, induction coils, galvanometers, telegraph instruments, dynamos, motors, etc. The directions are generally clear and explicit, but the amateur who has already a fair knowledge of electricity will, of course, gain much more from them than one who is ignorant of the subject.

Brown's Directory of American Gas Companies. Gas Statistics. Compiled and corrected by E. C. BROWN. Cloth, 7 × 10¼ ins., 184 pp. Press of *Progressive Age*, New York. 1890. Price, $5.00.

This, the third, issue of Mr. BROWN's directory includes data regarding 1,048 gas companies located in the United States, Canada, Cuba and Mexico. The officials of each company are given, together with the amount of capital stock, outstanding bonds, population of the city or village, process of manufacture, candle power of the gas, approximate annual output, number of public lamps and price received for same, and price of gas to private consumers.

There is also a separate list of natural gas companies, and of gas companies operating electric lighting plants. Regarding the latter the system in vogue and the number of arc and incandescent lamps are given. This is also stated in the body of the book, in connection with each gas company. The various parent or operating companies are also listed, and their officials and capital stock are given. In addition to the above the officials and members of several gas associations are given, the growth of the use of water gas, by systems, is shown with the aid of a diagram and the various processes of manufacturing gas are briefly described.

The only summaries in the book relate to the growth of the use of water gas and to electric lighting by gas companies.

It appears from the above that of about 1,100 towns in America having a gas supply, water gas has been adopted in 305, and that 367 water gas plants have been erected. The "Lowe process" takes the lead with 120 plants. The distinctive features of this process are said to be "the use of a generator in connection with a superheating or fixing chamber, fired by the internal combustion of the gases formed in blowing up the generator; also the introduction of oil, or other enriching substances, into the hydrogen gas, and the fixing of the two by passage through the superheater," etc.

The number of gas companies operating electric lights has increased from 266 in 1889 to 304 in 1890. The Thomson-Houston system takes the lead with 16,927 arc lights out of a total of 31,558 in 1889, and 45,055 incandescent out of 132,771 in 1890. It must be remembered that these figures are only for electric lights in connection with gas companies.

A large outline map shows each of the towns having gas plants in the United States and Canada. Altogether the directory is a great improvement upon the last issue, but it is to be regretted that more summaries have not been made and included. One wishes to know the distribution by States more accurately than it can be determined by counting the towns on the map, also something regarding the total cost of the gas plants in the country, and most especially the average price charged in each State and the United States per public lamp and per 1,000 cu. ft. to private consumers.

—*Steam*. By WILLIAM RIPPER, M. Inst. M. E., Prof. C. E. Sheffield Tech. School, etc. London and New York: Longmans, Green & Co. 12mo, pp. 202, 142 cuts; scant index.

The purpose of this little treatise, and one we may say at once which is very well fulfilled, is not to reveal any startling new truths about steam, but rather to condense into a small volume all the main elementary facts about steam and the steam engine, starting from the foundation and assuming little or no preliminary knowledge of the subject. The advanced student, therefore, or the professional mechanical engineer will find little in the volume to interest or instruct him, but it is admirably calculated to give to the beginner, in small compass, a kind of royal road to a very fair knowledge of the many different modes of using steam. Many civil engineers whose practice is not directly connected with steam engineering feel the need of just such a book, and we know of none which we could recommend to them with more confidence for such a purpose.

The general character of the work is sufficiently indicated by the statement in the preface, that it is based on notes of lectures delivered to an evening class of young mechanical engineers. The author has the gift of clear expression, from which he rarely lapses; and typographically the book is unexceptionable, as are most of the English scientific books which come to our table, it being beyond denial that the English scientific publishers show much better taste and judgment in this respect than do their American rivals. Their size and shape of page, choice of paper and type, execution and setting of cuts, and style of binding, all are better than most of our American technical publishers find grace to use; a fact the more remarkable since with non-scientific publications the balance of advantage is rather the other way. We have often before commented on this lamentable contrast, and shall continue to do so until the reform, which must surely come, begins to dawn.

Professor RIPPER's work opens with an elementary exposition of the nature of heat, with which we have no fault to find, except as to the closing sentence: "A horse power expressed in thermal or heat units $= \frac{33000}{772} = 42.75$." One who should have learned the difficulty of making young men comprehend the interrelation of force, distance and time should not at the very beginning of his subject use so loose an expression as this, implying that a horse power is merely 33,000 ft. lbs., instead of 33,000 ft., lbs. per minute. No reference is made to any of the later experiments which have slightly modified the JOULE equivalent of 772 ft. lbs., but this is probably with intention. Most practical work is still done with 772 instead of 773 or 774 and we think properly. JOULE came so near the truth that his equivalent should not be disturbed for so trifling a difference.

We notice another careless slip of language on page 18, not likely to deceive, perhaps, but such as should not occur: "Our best stationary engines consume about two pounds of coal per horse power per hour, or ten times as much as would be necessary if the whole of the heat could be converted into work. *This, however, can be shown to be impossible;*" "in the steam engine" was plainly meant to be understood, but should have been distinctly stated. A particularly good opportunity to impress on the student that the steam engine is at best a crude and wasteful form of heat engine, which there is great reason to hope will in time be vastly improved on, although we know not how to do it now, was here lost, nor do we find any reference to this important truth anywhere in the volume. On the other hand, the student is very neatly and clearly carried forward through the various possible methods of using steam, showing the economy which each develops; and the numerous examples further aid in keeping him abreast with his subject.

An unfortunate and surprising omission is that the nature of an indicator diagram and the process of taking it is no where clearly explained. It could not be expected that this should be done very fully, but two or three pages would have been well bestowed on it. The mechanical structure of the steam engine and the actions of the various valves is very well and clearly explained, considering the small space available. The theory of the compound engine is particularly well explained in a few pages.

The volume closes with some notes on the care of engines and boilers, and with a lot of questions and exercises and past examination papers. For the use intended, elementary instruction, it is a very good little text-book.

REPORTS.

—*Third Annual Message of Edwin H. Fitler, Mayor of the City of Philadelphia, with annual report of the Director of the Department of Public Works*, for the year ending Dec. 31, 1889. Pamphlet, 121 pp. LOUIS WAGNER, Director of Public Works.

As an appendix to the Mayor's report the city's returns for the eleventh census are given. These cover, in a brief way, the main facts regarding the government, public works and buildings, and charities of the city. The report of the Director of Public Works contains much interesting matter, some of which we will present in a latter issue.

—*Annual Report of the Commissioner of Dams and Reservoirs of the State of Rhode Island.* January, 1890. Pamphlet, 84 pp. L. M. E. STONE, Commissioner.

This is the eighth annual report of Mr. STONE. In it he comments upon the failures during the year of the North Scituate lower mills dam and the Spring Lake reservoir dam. Drawings of both these structures have been prepared, and are reproduced for this report, together with illustrations showing sections of 11 other dams. The number of reservoir structures in Rhode Island, reported to Jan. 1, 1890, is 435. We hope to present to our readers, at an early date, some parts of this report, which is one of the most interesting of the series.

SOCIETY PROCEEDINGS.

Civil Engineers' Club of Cleveland.—Regular meeting, July 8, 1890; President SEARLES in the chair; present 18 members and 3 visitors.

After some routine business, Mr. MORDECAI reported for the Committee on Affiliation that he had heard from Mr. HOLLOWAY, who had attended the meeting appointed in New York for conference, and that the attendance was very small and nothing was accomplished at that time.

The President read a letter from Mr. C. KIRCHOFF, JR., Secretary of the American Reception Committee, stating that owing to a change in the programme the party of foreign iron-masters and engineers will not visit Cleveland, although some individual members may be able to do so.

The amendments to the Constitution of the Association of Engineering Societies, proposed by the Board of Managers and published in the December number of the Journal, were presented for consideration. The first and second amendments were separately discussed and finally adopted.

A paper on "Methods of Wall Decoration" was read by Mr. C. O. AREY. After noting the objections to oil colors and kalsomining process, he narrated his experience with other methods. The encaustic process as practised by the ancient Greeks was found too expensive. The fresco practised by the early Renaissance was found satisfactory with the exception that the work was liable to be injured or broken after completion by the finishing carpenters. He then tried many experiments to find a method similar to this fresco which could be applied on a dry wall; this was accomplished by a chemical union of alum and lime-providing only mineral colors were used. This method allows one to apply on the wall a permanent finish unaffected by water at a very moderate expense. The paper was then discussed by Messrs. BARBER, HERMANN, RICHARDSON, PORTER and others.

After adjournment many members of the Club visited the fallen electric light mast, which was wrecked by the storm a few hours previous.

A. H. PORTER, *Sec.*

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COMING TECHNICAL MEETINGS.

Civil Engineers' Society, St. Paul, Minn.—Next meeting, Aug. 4. Secy., Geo. L. Wilson, City Hall.

Engineers' Club of Kansas City, Mo.—Next meeting Aug. 4. Secy., Kenneth Allen, 200 Baird Building.

Civil Engineers' Club, Cleveland, O.—Next meeting, Aug. 12. Secy., C. O. Palmer, 22 Cedar Ave.

Civil Engineers' Association of Kansas, Wichita Kan.—Next meeting, Aug. 13. Secy., J. C. Herring, Wichita.

Engineering Association of the Southwest, Nashville, Tenn.—Next meeting, Aug. 14. Secy., Olin H. Landreth, Vanderbilt University.

Engineers' Society of Western Pennsylvania.—Next meeting, Aug. 19. Secy., S. M. Wickersham, Pittsburg, Pa.

American Society of Civil Engineers, New York.—Next meeting, Aug. 6. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Next meeting, Aug. 6. Secy., W. H. Bryan, 30 South 7th St.

New York Railway Club.—Next meeting, Aug. 21. Rooms, 113 Liberty St.

Engineers' Club of Philadelphia, Pa.—Next meeting, July 19. Secy., Howard Murphy, 1122 Girard St.

Association of Civil Engineers, Dallas, Tex.—Next meeting, Aug. 1. Secy., E. K. Smoot, Elm and Austin Sts.

Western Society of Engineers, Chicago, Ill.—Next meeting, Aug. 5. Secy., J. W. Weston, 230 La Salle St.

American Society of Railway Superintendents, Boston, Mass.—Annual meeting at New York on the day preceding the fall meeting of the General Time Convention. Secy., C. A. Hammond, 350 Atlantic Ave.

In our report of the late Cresson convention the paper by Mr. J. LELAND FITZGERALD, Sanitary Engineer of Schenectady, N. Y., on "Comparison of Water Supply Systems from a Financial Point of View," on page 35 of our issue of July 12, was, by a slip of the pen, credited to Mr. DESMOND FITZGERALD of the Boston Water-Works.

In the same report we neglected to chronicle the fact that the spiral arch described in Mr. J. FOSTER CROWELL'S interesting paper was very fully illustrated and described in our issues of Oct. 20, 1888, *et seq.* We therefore do not give a further abstract of the paper.

THE article on brick pavement by Mr. CHAS. P. CHASE, of Iowa City, Ia., which is begun in this issue, is the most complete compilation of fact on that subject which we know of, and on that account we have added to it a brief index to the more important prior articles which have appeared in these columns on the same subject, with the hope that for a year or so we need do little more to keep our readers who are interested in pavements abreast with the latest progress.

It is beyond doubt that the use of brick for pavement is rapidly extending, and with good reason. It gives almost as smooth a surface as asphalt, a less slippery one, and one, in fact, which seems almost incapable of improvement so long as the general level is maintained, while the evidence is fast accumulating that with properly made and burned bricks the pavement is very durable. The good paving brick, however, is a vastly different and much stronger article than the good building brick, and when the latter alone is used early failure is to be expected. Nearly all the bad results with brick paving can be directly traced to such use of the wrong material or to bad foundations. We may add that the development of a special brick for paving purposes bids fair to give a new building material also. It is now under serious contemplation to use these paving brick for the foundations of one of the large new buildings in New York, the walls of these tall buildings getting so high that the softer building bricks are in great danger of crushing under the walls alone, unless made inordinately thick.

THERE was one paper read before the late Cresson Convention of the American Society of Civil Engineers, which we trust neither the author nor the society will permit to appear in its present shape. We refer to that on "A Practical Method for Reducing the Internal Wastes of the Steam Engine," by Prof. R. H. THURSTON. Prof. THURSTON conceived the idea, which so far as we know is a perfectly sound and happy one, that by a special mode of treatment the unfinished interior surfaces of a cylinder (*i. e.*, those not rubbed by the motion of the piston) could be given a graphitic coating which would make them comparatively poor conductors, and so save a large part of the very serious waste known as internal condensation. The idea in itself is not new, as is stated in the paper. Many previous attempts to carry it out have been made, but all of them heretofore with poor or no success. Prof. THURSTON devised a plan which he thought would be more effective, and took out patent No. 382,972 on it. The process, as practically tested, consists simply in first subjecting the parts to a bath of dilute sulphuric acid for 48 hours; then oiling the surfaces, and allowing them to dry for 24 hours. The remaining steps taken are thus described; the italics being ours:

> The effectiveness of this plan, as devised by the writer, *was determined*, and its influence on the efficacy of the engine was investigated, at his request, by Mr. P. M. CHAMBERLAIN, in the Sibley College laboratories, Cornell University, in the early part of the present year. An engine built especially for the laboratory and for experimental work by the Messrs. PAYNE, of Elmira, N. Y., was employed, and *the process consisted in measuring the flow of heat through its head* into a calibrated calorimeter. Several series of trials were made at various times, and under differing conditions, each usually lasting *forty minutes.*

Sixteen different tests are tabulated, for seven different processes, the last process and the last two tests only being Prof. THURSTON'S, none of them but his showing any special efficiency. The conclusions as to his process are thus expressed; the italics again being our own:

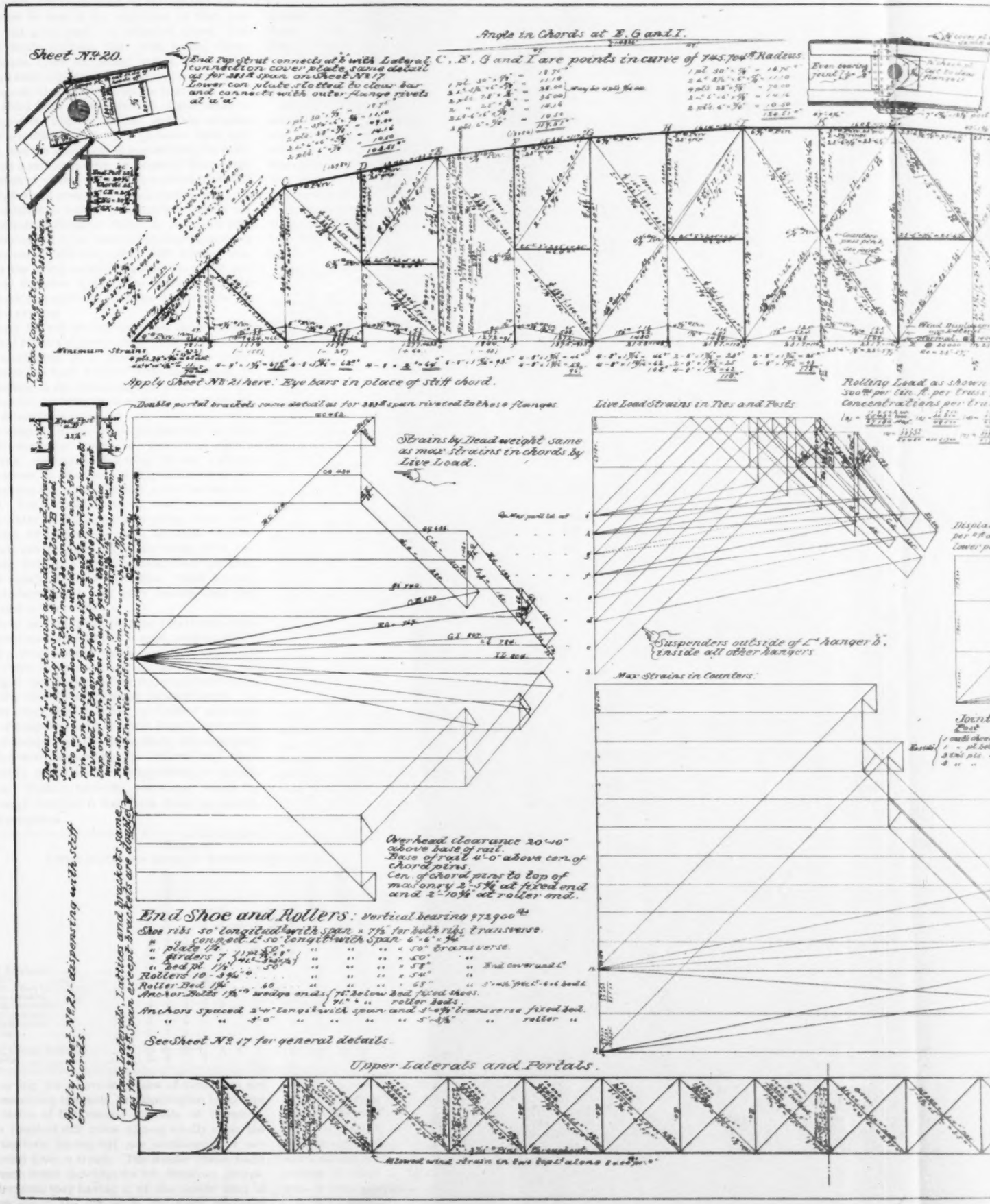
> By even a superficial treatment with acid and oil, the saving of heat [transmitted through the head of the cylinder under conditions above] is 40 per cent., and *this should measure the proportion by which internal cylinder condensation should be diminished.* With more prolonged treatment with acid and a more efficient absorption of oil and more complete drying, the gain *should* be considerably greater than here appears, and as will be hereafter shown. *The writer has estimated* that this simple treatment *should reduce cylinder waste by at least half*; which, in ordinary practice, means from 10 to 20 per cent. of all steam used, the figure being greatest with smallest sizes of engine.

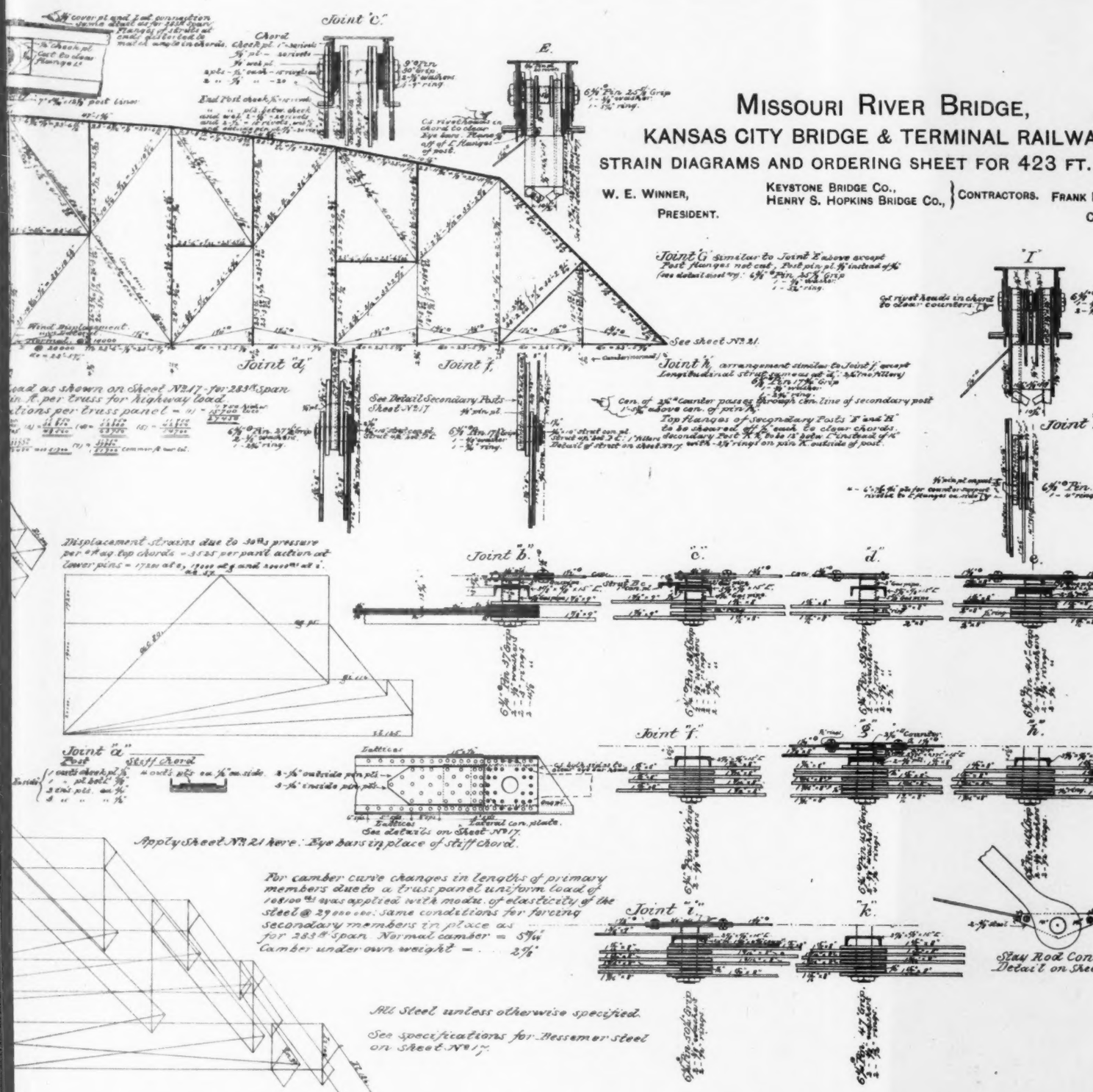
IT "should be" quite needless to say that this is building a pretty tall superstructure of conclusions on an exceedingly thin substratum of experimental fact; as also that, if Prof. THURSTON has in fact succeeded in effecting the saving he estimates, he has enrolled himself high in the list of the great improvers of the steam engine, and the future revenues from Patent No. 382,972 should be princely indeed, countable only in the millions. CORLISS was loaded with wealth and honors for doing less, yet his improvements required a wholly different construction, while the one now in question can be applied to any engine by a few hours' treatment. Nevertheless, we do not deny that the improvement may be a real one. We do not say that all claims made will not be more than realized. We hope they will be. But our faith that they will be is not much increased by such a loose presentation of most important claims as that above quoted, before even an attempt at direct experimental proof has been made, when direct investigation would have been so easy. The engine was there, "built especially for the laboratory." Why was it not run under a brake for 40 hours instead of 40 minutes, and measurement of the economy made directly by determining the work actually done per pound of steam, instead of by a dubious chain of deductions from an experiment which did not test at all the particular fact in question, viz., how much the *internal* radiation was reduced by the treatment in question? It may well be that the conduction of heat was much reduced when the internal radiation with quickly alternating strokes would be hardly affected at all. It is improbable, we admit, but there is sufficient chance for that and many other kinds of error (such as that the effect of the coating would wear out in a few hours or days, or that the "calibrated calorimeter" had something wrong with it) to make it seem highly improper for a scientific society or scientific man to publish claims for what amounts to a great discovery without first taking care that something like adequate proofs of the reality of the discovery shall accompany it.

The Filtering Plants of American Water-Works.

In our issue of June 21 we made some general comments upon the mechanical filtration of water, and mentioned, among other things, the comparative slowness with which the filtration of public water supplies has been introduced in this country. The number of filtration plants actually in use, so far as is known, together with their character and their distribution by groups of States, is shown herewith by means of Table F. Of 1,883 main water-works (*i. e.*, having their own source of supply) in the United States, 180 report some mode of filtration in use, and of these 180, seven have duplicate plants, or rather two plants of different character, thus making 187 filtering plants in the United States. In Canada, out of 84 main works, seven employ some method of filtration. Nearly half of the filtering plants in this country are in the New England and Middle States, 46 in each.

The different modes of filtration in vogue are, broadly speaking, three, if we class the mechanical, or *machine*, filters by themselves. The first group aims to employ natural filtration by building underground galleries in saturated soils and letting the water filter into them, either through porous walls or interstices in the walls. In addition, the water thus obtained is sometimes made to pass through filtering material in the bottom of


Sheet No. 20.
End Top strut connects at b with Lateral connection cover plate same detail as for 281 ft span on Sheet No. 17
Lower cor. plate slotted to clear bar and connects with outer flange rivets at a' a'
Angle in Chords at E, G and I.
C, E, G and I are points in curve of 745.70 ft. Radius
Even bearing
Apply Sheet No. 21 here. Eye bars in place of stiff chord.
Rolling Load as shown
Strains by Dead weight same as max. strains in chords by Live Load.
Live Load Strains in Ties and Posts
Suspenders outside of L hanger b, inside all other hangers
Max. Strains in Counters.
Double portal brackets same detail as for 281 ft span riveted to these flanges
Overhead clearance 20'-10" above base of rail.
Base of rail 4'-0" above cen. of chord pins.
Cen. of chord pins to top of masonry 2'-5½" at fixed end and 2'-10½" at roller end.
End Shoe and Rollers: Vertical bearing 972,900 lbs
Shoe ribs 50" longitud. with span x 7/8" for both ribs, transverse.
Connect. L 50" longit. with Span 6"x6"x7/8"
Plate 1/2" " " " x 50" transverse.
Rivets 7/8" " " " x 50" "
Bed pl. 1 1/4" " " " x 58" " Bed cover and L
Rollers 10 - 9 1/4" diam. x 50" " " " x 54" "
Roller Bed 1 1/4" 60 " " " x 63" " 5" web pl. 6"x6" bolts
Anchor Bolts 1 1/4" diam. wedge ends 76" below bed, fixed shoes.
" " " 71" " " roller beds.
Anchors spaced 2'-11" longit. with span and 5'-0 1/2" transverse fixed bed.
" " 9'-0" " " " " 5'-0 1/2" " roller "
See Sheet No. 17 for general details.
Apply Sheet No. 21 - dispensing with stiff end chords.
Portals, Laterals, Lattice and brackets same as for 281 ft span except brackets are doubled.
Upper Laterals and Portals.
Allowed wind strain in top lat. along 1 end pin.



MISSOURI RIVER BRIDGE,

KANSAS CITY BRIDGE & TERMINAL RAILWA

STRAIN DIAGRAMS AND ORDERING SHEET FOR 423 FT.

W. E. WINNER, PRESIDENT.

KEYSTONE BRIDGE CO., HENRY S. HOPKINS BRIDGE CO., } CONTRACTORS. FRANK

Displacement Strains due to 30lbs pressure per □ft on top chords = 3525 per panel action at lower pins = 1750 at 0, 1500 at 4 and 250 at 1.

For camber curve changes in lengths of primary members due to a truss panel uniform load of 108100 lbs was applied with modu. of elasticity of the steel @ 29 000 000. same conditions for forcing secondary members in place as for 283ft Span. Normal camber = 5 5/16
Camber under own weight = 2 5/8

All Steel unless otherwise specified.

See specifications for Bessemer Steel on Sheet № 17.

Floor beams, Stringers and all other general d on Sheet № 17 applies to this span.

Rivets generally 7/8" and spaced 3" at ends of all m and in connections generally.

Punch all rivet holes in tensile members and t tensile flanges 3/4" and ream to 7/8"

EMAIL HART & BOW

AILWAY.
23 FT. SPANS.

FRANK D. MOORE,
CHIEF ENGINEER.

Joint "k,"

Rod Con. Pl's.
on Sheet #17.

eral detail

of all members

and in

S. HART & SONS, LITH., 90 VESEY ST., N.Y.

the galleries. All wells filled by surface water partake more or less of the character of filter galleries, but none such are included above. The second mode includes filter beds, basins, chambers, boxes, dykes and dams; in fact, all filtration through artificial layers of filtering material, excepting only that included in the next class.

The third mode is an outgrowth of and improvement upon the first and second, and has resulted from the inefficiency of filter galleries, beds and basins, and the great cost of maintaining the same when on a sufficient scale to properly filter large quantities of water. It has also resulted from the desirability and need of removing from water matter in solution as well as in suspension, which the old methods of filtration failed to do to any considerable extent, or at least unless large quantities of charcoal or coke were used. Still another reason for the recent rapid increase in the use of mechanical filtration is the time required to clean filter beds and galleries, if of any size, and the attendant expense.

It may be well to state here that the terms mechanical filters and mechanical filtration are somewhat ambiguous, as at present used, and therefore there has been coupled with mechanical in the heading to the accompanying table, the word commercial, in order to distinguish more clearly these filters from from the old, stationary ones. The ambiguity in the word mechanical, as used in this connection, lies in the fact that, strictly speaking, mechanical filtration is the removal from water, in this case, of impurities by means of straining the water through some porous material. The material generally used, especially in this country, is sand, gravel or stone, or a combination of these, and such material removes scarcely anything but the matter which is in suspension, and may leave in clear and sparkling water deadly chemical impurities. Such impurities can be removed only after having been precipitated or coagulated.

It is at just this point that the superiority of the so-called mechanical filter is most evident, for by using a small amount of some coagulant or precipitant these impurities are so acted upon and changed that they may be caught and held by the filtering material as the water passes through. As nearly every filter included in Table F uses some sort of coagulant, and depends largely upon it for its advantage over the old methods, the ambiguity of the word mechanical is evident, and there should be coupled with it coagulating or precipitating. There is, however, one strong reason for the usage, and that is that these filters are specifically machines.

TABLE F.

UNITED STATES AND CANADIAN WATER-WORKS FILTERS.

	Galleries.	Beds and basins.	Hyatt.	National.	American.	Jewell.	Warren.	Olyphant.	Chambers.	Total galleries and beds.	Total mechanical or commercial.	Not given.	Grand total.
New England	17	17	1	..	..	..	1	..	..	34	2	10	46
Middle	5	24	7	2	..	..	..	..	..	29	9	8	46
South Atlantic	0	0	4	1	..	..	..	..	..	0	5	1	6
South Central	1	0	2	1	..	..	..	..	..	1	3	2	6
North Central	8	8	4	3	4	..	..	..	..	16	11	6	33
Northwestern	4	7	5	2	..	1	..	1	..	11	9	6	26
Southwestern	2	4	6	2	1	..	..	..	1	6	10	2	18
Pacific	2	2	1	..	..	..	..	..	..	4	1	1	6
Total United States	39	62	30	11	5	1	1	1	1	101	50	36	187
Canada	0	2	..	1	..	..	..	..	..	2	1	4	7

Leaving the above discussion of terms, we see by examining the table the distribution by groups of States of the various methods of filtration. New England still relies almost wholly upon the old methods, having but one commercial or mechanical filter, a Hyatt. The Middle States make a much better showing; the two Southern groups, better still, they having 8 of the newer kind of filters, one of the old, while the mode employed in three cities is not reported. Of 151 filters where the mode in vogue is known, 50 are of the commercial or mechanical type, and of these 30 are Hyatt, 11 National, 5 American, and one each Jewell, Warren, Olyphant and Chambers.

In Canada, of seven filtering plants the kind of four is not reported. Of the remaining three, two are beds or basins, and one is a National filter.

Of those plants of which the mode in vogue was not given in the reports from which the MANUAL was compiled, sufficient data was furnished to enable us to say that probably all of them are either filter galleries, basins, beds or similar plants, and that most of them are of the nature of small filter beds or chambers.

Considering the material used in filter beds, basins and the like, and in those galleries containing filtering material, we find the following practice:

Number using—	
Sand, gravel or stone, or a combination of these	59
" " " " " " together with sponge	1
Sand, gravel or stone, or a combination of these together with charcoal	17
Sand, gravel or stone, or a combination of these together with sponge and charcoal	2
Sponge and charcoal combined	8
Charcoal alone	3
Coke	1
Brick	1
Sponge alone	3
Total	95

The material that can be obtained both the easiest and the cheapest—sand, gravel or stone, or these combined—is used in 59 out of 95 plants, or in nearly two-thirds of the whole, and with sponge and charcoal, or these together, it is used in 79 out of 95, or over four-fifths of all the filters here classified. We find 19 filters using charcoal in connection with sand, gravel and stone, 8 more using it with sponge, and 3 using it alone, and, adding with these the one filter using coke, we have a total of 31 filters using more or less charcoal or coke, or almost exactly one-third of the whole number. We may very properly contrast these with the 64 plants not using such materials, as it is universally conceded that far better results are obtained by passing water through charcoal or coke than through either sand, stone, gravel, sponge or brick, alone or combined with each other, since charcoal or coke will remove not only the matter which is in suspension, but in addition to this will remove organic matter in solution, gases, coloring matter, odors, and bad tastes. The filters making use of charcoal and coke, therefore, are vastly superior to those relying wholly upon sand, stone, gravel or sponge, and it is encouraging to see that even one-third of the filter galleries, beds and basins of this country are using charcoal and coke to some extent or wholly. And if we added to these the 50 commercial or so-called mechanical filters, almost every one of which uses either charcoal or some coagulant or precipitant to accelerate and insure the removal of impurities in solution, then out of 145 plants we have 81 which remove both organic and mineral impurities, either in suspension or solution, against 64 which practically remove little or nothing but the impurities in suspension only.

Of the 42 remaining plants, about 20 are galleries, reporting no filtering material within, and therefore probably all relying upon natural filtration, which is generally many times slower than filtration through artificial layers of sand and gravel, and therefore much more complete, and approximating in value to filtration where charcoal or coke or some precipitant is used.

In this connection it should be stated that we have records of 19 filter galleries, beds, basins and the like, in the United States, not included in the summaries, that have been abandoned as useless, or practically so. In one or two instances the old filters have been abandoned for a commercial or mechanical filter. A few of the filters included in the summaries are reported as giving very much trouble, generally from clogging, and it is probable that more or less trouble of this sort is experienced with very many of them, largely arising from insufficient provisions for cleaning or from turbid water not first somewhat clarified by settlement. Doubtless more frequent cleansing and renewal of the filtering material would have obviated many of the difficulties encountered, and made abandonment unnecessary; but this has sometimes been deemed impracticable on account of the expense involved, and perhaps nearly as often neglect has been the cause of failure. Indeed, it is probably true that the majority of the filter beds, and the like, in this country are not cleaned or renewed oftener than once or twice a year, and some of them not at all. All infiltration galleries, or nearly all, cannot be cleaned at all, or at least the material about them cannot be cleansed without removing and replacing quite considerable quantities of sand and gravel, and generally at no small depth.

As there are in the United States 1,883 water-works, of which but 180, or less than one-tenth, report filtering plants, it is evident that there is a large field open to filter manufacturers and hydraulic engineers. For while it is true that many water-works stand in little or no need of filtering plants at present, increasing population, with the increase in the pollution of water supplies which will surely accompany it, will eventually render some mode of purification imperative, or else a rapidly increasing mortality will be the result. And with all that can be said or shown regarding the purity of our water supplies, there are very few that would not in some degree be benefited by filtration. According to table 10-S. in the introduction to the MANUAL for 1888, about 40 per cent. of the water-works in the United States, summarized for that issue, took their supplies from running streams. All these supplies need either filtration or subsidence to remove organic matter in suspension, and some need both, while comparatively few have either.

We showed in our issue of June 28, by means of Table 4-S, that 69.4 per cent. of the water-works in the United States and 60.2 per cent. of those in Canada pump either the whole or a part of their supply. A great number, both of pumping and gravity works, are so situated that a head sufficient to pass water through some or any kind of filter can be obtained before the water reaches the pump or goes into the supply main. Whenever this can be done, the wear of the pumps will be saved to a greater or less extent, depending upon the nature and amount of the matter which is removed; the supply mains, reservoirs and distribution system will also be kept clear, and thus the efficiency and economy of the whole system will be increased, as well as a better supply of water secured by filtration.

If such a head as has been mentioned cannot be secured, then in pumping systems the water can be made to pass through one of the mechanical or commercial filters before it enters the force main, the only difference being that the wear of the pumps is not saved. In gravity systems giving ample head in the distributing pipes a mechanical filter could generally be used somewhere on the supply main, or at least a filter bed, as the latter can be operated under comparatively slight pressure.

Referring again to the introduction to the last, 1888, MANUAL, we find that 6 per cent. of the water-works of the United States have for their supply, surface water; while nearly 26 per cent. take their supply from wells. Surface water, as here used, generally means water collected in reservoirs or ponds, from greater or less surface

areas, in distinction from such surface water as is collected in wells. It seems perfectly safe to say that all such water needs purification before being used for domestic purposes, as does much that is taken from surface wells.

We think it is evident to all who have given the matter even casual thought that the purification of the water furnished by the large majority of the cities and villages of the United States and Canada, is an important essential to the health and well-being of those communities, and that the chief method by which this purification can be secured is by filtration. We have seen that, allowing for filtering plants the existence of which is not known to us, only some 10 per cent. of the water-works of the United States and between 8 and 9 per cent. of those in Canada employ filtration. Whatever the number of those without filtration and needing it may be, it is certain that here is a wide and constantly growing field of action for all who are interested in securing for the people of our cities and villages a pure water supply, whatever their motive may be; and it should be borne in mind that the responsibility of having pure water in any village or city does not rest upon the city officials or the water company alone, but upon each tax-payer, since from the latter come both the vote and the money which are the first essentials in securing either a new water supply or any extensive improvements in an old supply.

As to the mode of filtration which should be adopted in a given case, expert advice alone can determine. But there are some general principles which it may not be out of place to mention here. First, it may be stated that where thorough investigation shows that there needs to be removed from the water only matter in suspension, and that largely of a coarse nature, filtration through sand and gravel may often suffice. Secondly, if the water contains very fine organic matter, some of it in solution, or if it contains gases, or if it tastes, smells or looks dirty, it may often be rendered potable by filtering through charcoal or coke, probably with better results, and certainly more cheaply, if it first passes through sand, thus removing the grosser materials. Either of these methods might be employed to advantage, and with comparatively slight cost, in connection with water-works, furnishing consumers with what is generally, and often rightly, considered very good water when unfiltered.

The third principle is founded on the fact that a great number of our available water supplies are so contaminated as to make impracticable and often utterly impossible their proper purification by either of the above methods, thus necessitating the use of some precipitant, and making advisable the use of one of the mechanical or commercial filters. Indeed, any water-works officials who contemplate the introduction of filtration in any form will make a mistake if they do not examine the merits of the various mechanical filters before coming to a decision, as efficiency and cheapness of operation are the main claims of their manufacturers, and, so far as we can judge, well-merited ones.

An important element in judging of the efficiency of filter beds and basins is the area and depth of the filtering material and the amount of water which must be passed through it per square foot in a given time. Much can also be learned from the recorded failures of filter beds and basins; but lack of space forbids the consideration of either of these subjects in this issue, and, besides, it seems advisable to wait until some further data can be collected, in order that a more intelligent and extended study of these latter questions may be made.

Rapid Transit Subaqueous Tunnels.

The papers have been full recently of two or three projects for passing the North and East Rivers by subaqueous tunnels, in which the necessary dip downward to pass under the river is to be utilized to propel cars by gravity on the roller coaster or toboggan slide principle, the cars acquiring a great velocity in descending an inclined approach, which carries them quickly under the river and a considerable distance up again on the other side. It is further proposed that when the speed falls to about 15 miles per hour on the ascent the train shall automatically grip a cable which will haul it up the remainder of the ascent, the only work done by the cable being that necessary to make good the loss by friction.

The leading project of this kind, and, perhaps, the origin of all the others, is one proposed by the East River R. R. Co., of which Major B. S. HENNING is stated to be the President, and GEO. S. MORISON, Consulting Engineer. The general nature of the scheme, but by no means its details, is shown in the accompanying cut. Major HENNING is stated, in fact, to have a patent on the plan, which can hardly be possible as regards the main elements of the project, since they are all a good deal older than engineering, and perfectly well understood. On many details it may, no doubt, be perfectly justifiable to grant patents. That it can be necessary to infringe on any valid patent to construct a tunnel on this principle we can hardly believe; whether it is or not, is apart from the present subject, however, which is the mechanical merits of such a scheme.

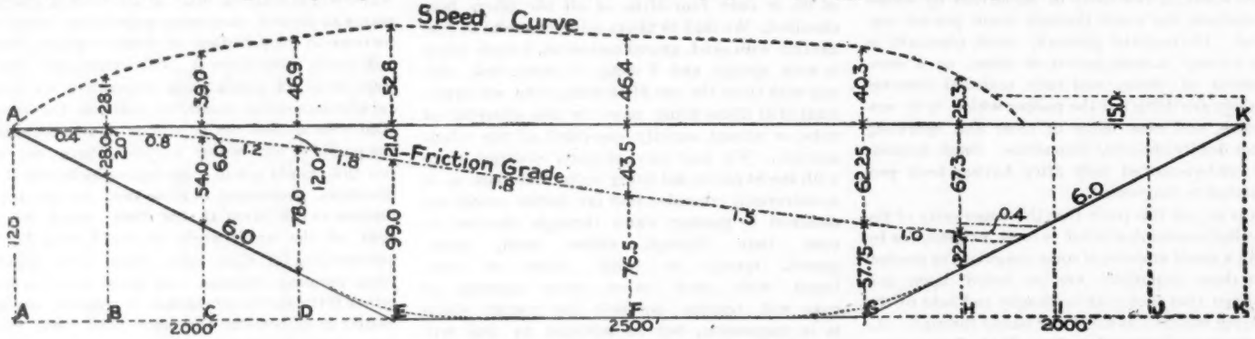
We believe and long ago said that a tunnel on this principle is entirely feasible, and would offer certain decided advantages, but the details of the scheme as outlined seem to us open to serious criticism. Did not the main idea seem good it would be hardly worth while to discuss these details. As it is good, it may be well to outline the essential conditions for success in such a project, and the degree of advantage which may be reasonably hoped from it.

We have sketched in the accompanying cut a typical case of such a tunnel, not referring to any particular location, but illustrating how any such tunnel must be constructed and operated.

In any such tunnel the rails must be about 100 ft. below the surface of the river, which will bring it something like 120 ft. below its terminal points. This depth, allowing the combined depth of water and height of tunnel to be 50 ft., allows only 50 ft. of solid material above the tunnel, and this is likely to be the least which is desirable. Moreover, about this amount of dip below the starting point is desirable to obtain the necessary velocity in passing under the river.

Given such a tunnel as outlined in the cut, with approach grades of any rate (we pass for the moment the question of what grade is proper) the theoretical operation of such a tunnel is simplicity itself. On page 335 of "The Economic Theory of the Location of Railways" is given a table of the "Total Energy of Potential Lift in Trains moving at Various Velocities," from which, given the velocity in miles per hour, the total height in vertical feet may be determined, through which the energy represented by that velocity is able to lift the train; or conversly, given the vertical feet of fall, the velocity represented by that fall may be determined.

The velocity represented by a vertical drop of 120 ft. is slightly over 58 miles per hour. Consequently, if there were no loss from friction or air resistance, a train or car, starting from a state of rest at A and running down a grade of any rate whatever to E, 120 vertical feet lower, would have a velocity at E of 58 miles per hour, and its average velocity from A to E would be precisely half of this, or 29 miles per hour. From E to G the train would continue in motion at 58 miles per hour, and from G to K would gradually lose speed, coming to rest at some point K, at the same level as A, the average speed from G to K being the same as from A to E, or 29 miles per hour, regardless of whether the two rates of grade were equal. Consequently, in the diagram above, the total theoretical time of passage would be:



A TYPICAL SUBAQUEOUS GRAVITY TUNNEL.

A to E and G to K, 4,000 ft. at 29 m. p. h. (42.6 ft. per sec.)	94 sec.
E to G, 2,500 ft. at 58 m. p. h. (85.2 ft. per sec.)	29 sec.
Total (2 min. 3 sec.)	123 sec.

An average speed of 36.4 miles per hour.

Practically, we should not nearly attain this average, owing to the retardation by friction, but before we consider this case, let us take another modifying cause.

A great theoretical saving of time can be effected by steepening the approaches, for it will be seen above that about three-quarters of the total time of transit is consumed on the approaches. Let us assume that instead of using the 6 per cent. approach grade shown in the cut, it were admissible to use a grade as steep as 25 per cent., or 1 in 4, which is the grade which has been actively urged for such a project. The approaches then become only $120 \times 4 = 480$ ft. each, instead of 2,000 ft. long, and the theoretical total time of passage will stand as follows:

A to E and G to K, 960 ft. at 29 m. p. h. (42.6 ft. per sec.)	22½ sec.
E to G, 2,500 ft. at 58 miles per hour, as before	29 sec.
Total	51½ sec.

An average speed of 45¾ miles per hour.

It is to effect this great apparent gain in average speed, from 36.4 to 45¾ miles per hour, as well as to save cost of construction, that it is proposed to

use extremely sharp descents to the tunnel at each end.

The actual necessary time of passage, however, is quite different from the theoretical, owing to the air and rolling resistances, which continually increase with the speed, and materially decrease it by destroying a part of the energy represented by the fall. In a tunnel the air resistance especially is likely to be very considerable, and it is impossible to estimate in advance precisely what it will be; but a close approximation may be made by dividing up the approaches, say, into quarters, by points *B*, *C*, *D* in the cut above, and estimating the resistance and speed on each. Thus, in starting, the resistance will be, say 8 lbs. per ton, which is equivalent to an 0.4 per cent. grade. This destroys $0.4 \times 5.00 = 2.0$ vertical ft. of the 30 ft. fall to *B*, leaving only 28.0 ft. of this fall to go toward increasing velocity. The speed corresponding to this fall is, by the table referred to above, 28.1 miles per hour.

From *B* to *C* the resistance will certainly be considerably more, because the average speed will be over 30 miles per hour. About 16 lbs. per ton, equal to an 0.8 per cent. grade, is not an excessive allowance, whence it follows that $0.8 \times 5.00 = 4.0$ ft. more, or 6.0 ft. in all, out of the 60 ft. fall to *C*, will have been lost by resistances, leaving 54.0 ft. to be represented by velocity. The velocity corresponding to 54.0 ft. of fall is 39.0 miles per hour.

From this on the resistance will be still more, say about 24.0 lbs. per ton, = a 1.2 per cent. grade, destroying $1.2 \times 5.0 = 6.0$ ft. more of head or 12 ft. in all so far, whence $90.0 - 12.0 = 78.0$ ft. of fall to have taken the form of velocity at *D*; and and 78.0 ft. corresponds to 46.9 miles per hour. Similarly, making the allowances for the successive friction grades shown, we obtain 52.8 miles per hour for the speed at *E*, 46.4 miles per hour at *F*, in the middle of the tunnel, 40.3 miles per hour at *G*, 25.3 at *H*, and at some point between *H* and *I* the train will come to a rest, losing speed very rapidly on the up grade. Just before it does this, or when it has still 8.0 vertical feet of energy left in it (15 miles per hour speed) it is proposed to have the car or train automatically grip a cable moving at that speed, and be carried up to the end of the tunnel at *K*, the cable simply making good the loss by friction, and hence only running part way down the approaches.

The actual time of passage under these conditions will be as follows (the average speed between any two points being precisely equal to the average of the initial and terminal speeds):

	Average M. p. h.	Dist. ft.	Time secs.	
A to B	14.05	500	24.2	
B to C	33.55	500	10.1	
C to D	42.95	500	7.9	
D to E	49.85	500	6.8	
				49.0
E to F	49.60	1,250	17.1	
F to G	43.35	1,250	19.6	
				36.7
G to H	32.80	500	10.4	
H to I	20.15	200	6.8	
I to K	15.00	1,300	59.0	76.2
Total (2 min. 42 secs.)				162.9

An average speed of 27⅛ miles per hour.

It will be seen, therefore, that, in spite of the high maximum speed of 53 miles per hour, the average speed is in no way remarkable. By steepening the approach grades, as we have before noted, the apparent average speed is increased, because there is not time to lose so much head by friction on the approaches. Without going through the details of the calculation the speeds and times will stand about as follows:

	Average speed. M. p. h.	Ft. per sec.	Dist. Ft.	Time. Sec.	
A to *B*	14.40	21.2	120	5.7	
B to *C*	34.55	50.7	120	2.4	
C to *D*	46.10	68.7	120	1.8	
D to *E*	54.15	79.5	120	1.5	
					11.4
E to *F*	53.10	78.0	1,250	16.0	
F to *G*	46.40	68.1	1,250	18.4	
					34.4
G to *H*	36.85	54.1	120	2.2	
H to *I*	22.85	33.6	120	3.6	
I to *K*	15.00	22.0	240	10.5	
					16.3
Total (over 3,460 instead of 6,500 ft.)					62.1

An average speed of 37.9 miles per hour.

It will be seen that the average speed *between termini* is considerably increased by using very steep approaches, but then the distance between termini is very much reduced, so that the traveler has so much further to walk or ride in order to reach the tunnel. Now, little traffic indeed is likely to originate on the immediate shores of the river. It comes from some distance back, and is to be carried some distance beyond. The true basis of comparison is for transportation over equal distances, say 6,500 ft. In that case we have, for steep approach tunnel:

	Secs.	Miles per hour.
Time through tunnel-proper, as above	62.1	37.1
Time for passing over 3,040 ft. for approaching and leaving the same, making 6,500 ft. in all, say	259.	8.0
Total time and average speed for 6,500 ft	321.1	13.8
While with the continuous tunnel with 6% approaches, we have as above	161.9	27⅛

It will be seen, therefore, that there is a great loss of time, instead of gain, in using steep approaches; but another cause which should absolutely condemn them is the disagreeable and even dangerous sensation which passengers would have in so suddenly acquiring speed. It would no doubt be a perfectly smooth and (in that sense) gentle increase, but its suddenness would be such that there would be no material difference in the resulting sensations between it and sliding down the roof of a house on a roller coaster. In a distance of $4 \times 8 = 32$ ft. a speed of 15 miles per hour would be attained, and in a distance of $14.2 \times 4 = 56.8$ ft. a speed of 20 miles per hour. The elevated railway trains start off pretty promptly, but they take an average of 130 ft. to get speed up to 10 miles per hour, and over 500 ft. to get up to 20 miles per hour. In other words, a 25 per cent. grade would start off trains about nine times as suddenly as they are started on the elevated railway.

This would certainly be injurious to a few passengers, alarm many, and be disagreeable to all. As a tunnel laid out in this way also involves a great sacrifice of average speed, in spite of the apparent gain, it should be in no case permitted. The arguments in favor of it are only that it reduces cost of construction and the length of the terminal cables needed, which need be only 250 to 300 feet long with the very steep approach, whereas, with 6 per cent. approaches, they must be nearly 1,500 feet long.

The speed acquired is little affected by the assumed resistances. Thus if we assume these to be as much as 2 pounds per ton higher or lower than those shown in the cut, it will only vary the "vertical head" about 5 feet at H, and affect the final point at which the train comes to rest about as indicated by the dotted lines.

As for the general merits of the scheme, assuming the approach grades to be reduced to about 6 per cent. as shown, we are disposed to think favorably of them. There can be no real difficulty in grasping the ascending cable as the speed falls to its rate, either automatically or by hand work, or both. Using no motor of any kind within the tunnel would be of great advantage; the speed at no point is excessive; with proper guard-rails and care in maintenance the risk of derailment could be almost eliminated, while in case of any sudden stoppage from accident it would seem easy to provide for automatically, or otherwise, signalling danger to the rear, and it is not contemplated, moreover, to have more than one train in the tunnel at a time. This may be difficult to insure, but automatic block signalling has been brought to quite sufficient perfection to make it easy to insure proper intervals between trains under all conditions.

On the whole, we are disposed to think that tunnels of this kind, properly laid out and constructed, would prove a feasible and very satisfactory method of passing rivers dividing great cities, with this great advantage over bridges, that the dip downward helps to rapid transit, while the upward grades of a bridge hinder it; engineers will all wish that the experiment should be made, at any rate.

CORRESPONDENCE.

A Chimney Which Doesn't Draw.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: We put up for a brick kiln an iron stack, 70 ft. × 5 ft. diameter, on a 20 ft. brick base. It does not draw. The moisture in the brick creates a steam which sweats the stack, so much so that the water runs down, and this steam seems to fill the area of the stack with such a dense, heavy air as to spoil the draught. It is proposed to put 20 ft. more on top of the stack. But the question is, will this remedy it? No one suspected for a moment that an iron stack would not answer as well as a brick stack. Could you give us any advice? J. B.

[It seems improbable that raising the stack higher would have any good effect. An interior lining of one course of brick, or of any other non-conducting material, for some considerable height, would be more likely to be effective; or a double outer shell might answer the same purpose.—ED. ENG. NEWS.]

The Laws of Air Resistance.

WASHINGTON, D. C., July 9, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The various discussions recently published in your journal under the title of "The Laws of Air Resistance" lead one, I think, to the most obvious of all conclusions that, notwithstanding Prof. HAZEN's assertion that there is nothing so well established as the law of variation as the *square of the velocity*, yet after all only a little is definitely and actually known of these laws.

The subject has been of particular interest to me from the fact that the parallel question, namely, the measurement of wind velocities has under the direction of the Chief Signal Officer, been already subjected to experimental study by me, and preparations are now being completed for the extension of the work and the further study in the next few weeks of the question of wind pressures by means of pressure observations in the open air under the conditions of high-wind velocities that occur on Mount Washington, N. H.

I wish to remark briefly upon two things:

(1) What we know of the laws of air resistance, and (2) how we can determine the laws of air resistance?

(1) At present our knowledge, both theoretical and experimental, of the laws of air resistance and wind pressures is more or less tentative in many respects. The constants of theoretical formulæ require experimental determination, and experiments thus far have led to a great diversity of results. Not only the extent of the surface presented to the action of the air, but also its form and character as well as its angle of inclination to the line of relative motion, and the form and character of the objects immediately behind, all enter in to influence the total amount of resistance encountered.

The problem, when all these questions are considered, becomes very complicated, but the separation and estimation of these several effects and the development of equations therefore really constitute refinements of the main problem that can well be set aside until the primary question of the true normal pressure on a plane surface normally exposed is more definitely settled than at present. Upon this latter question experiments differ very much. It is considered, however, that the weight of experimental testimony is to support the theoretical considerations by which air resistances are made to vary as the square of the velocity.

The most recent experiments, so far as I am aware, that favor this law are those made by Messrs. WHIPPLE and DINES, of the Windforce Committee of the Royal Meteorological Society. Accounts of their experiments made upon a large whirling machine are to be found in the recent numbers of the Quarterly Journal of the Royal Meteorological Society.

HAZEN's experiments, still supporting the law of squares, indicate that the resistances per unit area are slightly greater the greater the total area.

While other experiments have given somewhat negative results in respect to this point, the rather astonishing statement is now being put forth that pressures per unit area vary *inversely* as the total surface. This conclusion is reached from experiments made upon the Eiffel tower, a note in regard to which is given in the ENGINEERING NEWS of June 28, page 619. [Experiments by the editor, made in 1876, seemed to indicate this quite strongly.]

Mr. CROSBY's experiments are the only ones I know of that indicate a linear law of air resistance, and it is of the utmost importance that the accuracy of his methods of experimentation be demonstrated beyond question.

The greatest uncertainties are unavoidably introduced by the use of a whirling apparatus of no greater radius than 5½ ft., and it seems almost out of the question to expect much accuracy from experiments under such conditions, especially at such very great velocities.

The actual *relative* velocity of the air and the whirled

plates may. I think, be vastly different from that of the whirler itself. It is very remarkable, however, that the car and whirling experiments agree as they do. Having only such incomplete information in respect to the details of Mr. CROSBY'S experiments and methods as may be gained from his published articles, it is difficult to point out defects of such a serious character as to consistently indicate a linear instead of a quadratic law of air resistance. Nevertheless, I am inclined to strongly doubt that a linear law is a true one.

(2) The recent discussions have presented not only new results but have also suggested new lines of experimentation, and this too, I think, with no little confidence in their sufficiency to lead to an easy and complete solution of the problem. It is not my intention to say how I think experiments upon this important question should be made. Indeed, the more I have thought of it, the more apparent have become the difficulties, and the more stubbornly the sources of error refuse to be eliminated or determined. In undertaking an experimental study of such a complicated and difficult problem as the laws of air resistance, it is impossible, of course, to lay out, before hand, a definite plan of procedure.

Various sources of error that can hardly be fully anticipated are almost sure to develop during the progress of such work, and frequently are only eliminated by radical changes in methods, etc. There is no doubt that, aside from certain necessary facilities, almost everything depends upon the experimenter himself; one of whose special qualifications should be his ability to recognize and ferret out the errors of his own work. The varied results thus far obtained by the use of the favorite whirling machine tends strongly to support the above statement.

In seeking an experimental solution of this problem, one needs to be able to measure under all the varied conditions: 1st, the absolute relative velocity of the air and the body; 2d, the total pressure resulting from the relative motion; and it is necessary that all the varied conditions be wholly subject, if possible, to the control of the operator.

The merits of different methods of experimentation may be judged in some degree by the facility with which the above mentioned measurements may be made, and the extent to which other conditions may be realized.

Each method is sure to possess some special advantage, but it is also inseparable from corresponding disadvantages.

A car rolling down a grade places the question of velocity quite beyond control. A certain extent of surface cannot easily be propelled at widely different velocities. Uniform velocities are, under such circumstances, very largely a question of chance. The rolling and other car resistances are presumed to be constant, but I am almost sure that in careful work one would suddenly find it necessary to look very carefully after car resistances, and possibly find them very troublesome. In fact, it would be impossible to avoid direct measurements of actual pressures on the surfaces exposed.

In the case of cars pushed by an engine, the velocity is under almost perfect control, though the motion is possibly less smooth and easy. Nevertheless, this method seems superior to the other, though they are both open to additional objections in that the cars and engine are themselves very large and bulky things and occupy a large amount of space, as compared with the surface or object the pressure upon which is measured. This raises a doubtful question of what the influence of these accessories may be. It is also necessary, in these car experiments in the open air, to eliminate the effect of prevailing winds. Prof. HAZEN thinks this can be done by closing up the sides of the car, possibly also the top, and conducting the experiments within this tunnel-like space. It is argued this would cut off all winds not in a line with the track. The presence of the additional structure, however, only aggravates the objectionable conditions mentioned above, and it is not clear that any winds except those exactly at right angles to the track would be entirely intercepted.

The Signal Service is already indebted to the Washington Monument and the able engineer who had charge of its completion for peculiar opportunities for the study of atmospheric electricity, and would endeavor to utilize the great shaft still further, if possible; but we cannot agree with Mr. CROSBY that this offers any opportunity for the solution of the question under consideration. The velocity of falling objects is almost entirely beyond control, and must, except for exceptional cases, be rapidly accelerated. We cannot yet say, I think, that, for the same velocities, pressures are the same under uniform and accelerated motion. Again, uniform velocity, if it did occur, or, unless it was a very low velocity, would obtain over the last portion of the descent and could only be measured over a short space in a very short interval of time; conditions under which small errors lead to seriously incorrect results. The mechanical devices serving to guide the falling objects and electrically determine the velocity will, I think, prove very difficult to realize free of serious defects and objectionable influences on the problem to be solved.

In the case of the use of whirling machines, we find that the question of the control of the velocity is as complete as can be desired, and its measurement is only vitiated by the so-called "mit-wind," which latter is greatly diminished in the case of long arms. Twenty-eight feet (more accurately, 28.011 ft.) is a good length, and is not so long as to offer serious difficulty in securing desired rigidity, etc. Such a length has, as a little computation will show, the further advantage that the linear velocity of the extremity, in miles per hour, is exactly twice the number of revolutions of the arm per minute. This, however, is nothing more than a convenience.

Aside from the question of mit-wind, other objections may be raised, first, in respect to the motion not being rectilinear, thereby giving rise to different velocities at different portions of the same plate, and, second, in respect to the centrifugal effects upon different parts of the recording or measuring mechanisms.

These are certainly no more serious than various objections to other methods, and one special advantage presented by no other method thus far advanced is the facility and completeness with which the various conditions may be subjected to the control of the operator. I am, therefore, disposed to think that much valuable work is yet to be done by the use of whirling machines. Very valuable checks can, no doubt, be obtained for certain favored points by the other methods, but they are not so well adapted to a primary and comprehensive study of the problem.

The above discussed objections are not the only ones, by any means, that may arise, but it is desired to divert, if possible, the attention of some who have been considering the problem of air resistances to a more careful consideration, in detail, of some of the real and serious obstacles to be encountered.

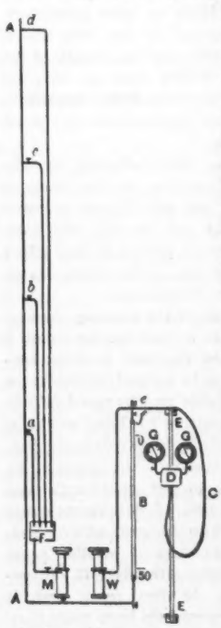
The highly discordant results obtained by different investigators is a direct proof that these obstacles have not received sufficient attention, and that there is a disposition to ignore, or overlook, certain side issues that appear unimportant.

C. F. MARVIN.

[By dividing a descent of say 500 ft. into a dozen or twenty stations, the average velocity between all but the first three or four will not accelerate sufficiently to vitiate the result, even if it be true that air resistance for accelerating velocities is not the same as for constant velocities. Nor do we perceive why it is at all necessary to "control" the velocities. If a sufficient range and number of velocities be obtained, it matters not what may be the precise velocity of each separate test.—ED. ENG. NEWS.]

An Open Mercury Column for High Pressures.*

The mercury column described in this paper is the result of an attempt to provide for the testing of spring gauges used in connection with the work carried on in the Mechanical Laboratory of the Worcester Polytechnic Institute.



An Open Mercury Column for High Pressures.

The object was to design a column which would give pressures from atmospheric to 200 lbs. per sq. in., or higher if needed; it should be sufficiently accurate for engineering purposes and at the same time not expensive, and, if possible, should provide for taking readings at one convenient point.

In the illustration *AA* is a small iron tube connected at the lower end with the glass tube *B*, which in turn is connected by a flexible tube *C* with the gauge or gauges *GG*. They are fastened to the carriage *D*, which runs on the rod *EE*. The tube *AA* in this case is made up of four sections, each section being of sufficient length to give a pressure of 50 lbs. when filled with mercury at 62° Fahr.

The method of operating is as follows:

By means of the pump *M* mercury is forced into the column. It rises in both the iron and glass tubes, the cock *e* being open. When the mercury in the iron tube reaches the end of the first section it passes through the valve *a* and down an overflow pipe to the collector *F*. This fixes the zero mark on the scale. Water is then put in at the top of the glass tube by means of the pump *W*, and fills the top of the glass tube and the flexible tube *C*. Closing the cock *e*, more water is forced in, and the mercury in the glass tube is displaced, thus forcing more into the iron tube, the result being an overflow at the valve *a*. Thus the mercury can be lowered to any desired reading between zero and 50, while the level in the iron tube remains the same, the gauges being moved up or down to correct for the column of water. The operator at any time can easily assure himself of the level of the mercury in the iron tube by forcing in more mercury until some comes down the overflow.

When pressures from 50 to 100 lbs. are desired, the gauge is corrected or its correction noted, if any, for 50 lbs., by the first section, the valve *a* closed and mercury forced in until it comes down the overflow from the valve *b* and stands at zero in the glass tube, the water having been returned to the pump or allowed to escape. The gauge being brought to the proper place, the reading should be 50, or show the same as at the end of the first section. This gives a means of checking the measurement of the tube from *a* to *b*. The operation is now the same from 50 to 100 as from zero to 50. And by closing the valves *b* and *c*, pressures from 100 to 150 and 150 to 200 are obtained. More sections can be added if higher pressures are desired.

By closing the valve *f* two gauges can be compared by changing the water pressure with the pump *W*.

By some simple means the valves *a*, *b* and *c* could be opened and closed from below, and thus a gauge could be tested from zero to 200 or higher, with an open mercury column, without going up more than 8 or 10 ft. to take readings.

The column at the Institute was built in general after this plan, and is giving good results.

*A paper by W. W. BIRD read at the Cincinnati meeting of the American Society of Mechanical Engineers.

The Growth of Chicago.

The Chicago *Tribune* takes issue with Mr. CHAUNCEY M. DEPEW in regard to certain disparaging remarks of his in regard to Chicago's financial capacity, and in doing so gives the following interesting figures of Chicago's growth in recent years:

It is estimated, in round numbers, that $50,000,000 worth of buildings were destroyed by the fire of 1871. A considerably larger sum than that was expended in the next five years replacing buildings and erecting new ones. For the years 1877–81, inclusive, there was an average of 1,200 new buildings constructed annually, at a total cost of $41,340,970. In 1882 Chicago entered upon a new and vastly increased prosperity, new buildings being erected in that year to the number of 3,118, at a cost of $15,842,800, and since that time there has been a steady annual increase, as follows;

Year.	Buildings.	Cost.
1883	4,086	$17,500,000
1884	4,169	20,089,600
1885	4,638	19,624,100
1886	4,664	24,324,400
1887	4,833	19,778,100
1888	4,958	20,360,800
1889	7,590	31,516,000

In 13 years, 1877–89, Chicago has put up 44,632 buildings, representing a cost of $207,976,779, occupying a frontage of 1,090,475 ft., worth $31,500,000. Chicago has, therefore, about $258,000,000 in buildings.

If these figures be attentively studied, they give an impressive exhibit of Chicago's rapid growth. One thousand two hundred buildings per annum, averaging $7,000 each in cost in 1880; 3,118, averaging $5,100 each in 1882; 7,590, averaging $4,160 in 1889; 63 per cent. of the total loss by the great fire of 1871 being now added to the city yearly. This is truly a great showing, and we have no doubt that Chicago will derive a great further impetus from the "Columbian Fair." The average cost of buildings has been naturally decreasing since the fire, both by cheapening of the cost of materials and by there being a smaller proportion of great business and public buildings to renew.

Power Used by Machine Tools.

The following useful little table giving the horse power required to drive various machine tools was compiled by Mr. ROBERT E. DINSTON, Plantsville Conn., for the *Electrical World*:

(1) Shop shafting 2 3-16 ins. by 180 ft. at 160 revolutions, carrying 26 pulleys, varying in diameter from 6 ins. to 36 ins. and running 20 idle machine belts, 1.32 H. P.

(2) Lodge-Davis upright back-grand drill press, having table 28-in. swing, drilling ¾-in hole in cast iron, with a feed of 1 in. per minute, 0.78 H. P.

(3) Morse twist drill grinder No. 2, carrying 26-in. wheels at 3,200 revolutions, 0.29 H. P.

(4) Pease planing machine 30 × 36 ins., table 6 ft., planing cast iron, cut ¼ in. deep, planing 6 sq. ins. per minute at 9 reversals, 1.06 H. P.

(5) Shaping machine 22-in. stroke, cutting steel die, 6-in. stroke and ⅛-in deep, shaping at rate of 1.7 sq. in. per minute, 0.37 H. P.

(6) Engine lathe, 17 ins. swing, turning steel shaft 2⅜ ins. diameter, cut 3-16 in. deep, feeding 7.22 ins. per minute, 0.43 H. P.

(7) Engine lathe, 21 ins. swing, boring cast iron, hole 5

ins. diameter, cut 3-16 in. deep, feeding 0.3 ins. per minute, 0.23 H. P.

(8) Sturtevant No. 2 monogram blower at 1,800 revolutions, no piping, 0.8 H. P.

(9) Heavy planer, about 28 × 28 × 14 ft. bed, stroke 8 ins., cutting steel, making 22 reversals per minute, 3.2 H. P.

Retaining Rings for Driving Wheel Tires.

American experience in respect to fastenings for tires has been limited indeed as compared with that gained abroad, for the reason that the chilled cast iron wheel has been, until lately, in all but universal use for all railway wheels except locomotive driving wheels, whereas, abroad, almost every wheel which runs on the rails has a tire. As driving wheels are looked after with vastly more care than any of the other wheels of the train, the natural consequence has been that, whereas serious accidents from broken tires have been exceedingly rare here (and it must be admitted that they have rare), tires have been a very common cause of accident abroad.

Nevertheless, when an engine tire does break, the result is apt to be a very much more serious accident than when a car wheel tire breaks, and such accidents do from time to time occur. The latest proof of this, of any moment, is the terrible St. George, Ont., disaster on Feb. 27, 1889, causing 13 deaths and 29 injuries, the cause of which was the breakage of a pretty old and thin tire just after running over a stub switch at high speed, and just before coming to a high bridge with an old-fashioned and hence imperfect bridge floor. The cost of this accident alone to the Grand Trunk Railway will probably be in the neighborhood of half a million dollars, directly and indirectly, all of which would have been saved by the use of the simple device shown in the accompanying illustration, costing only $73.17 per engine for the first application, and $19.49 per engine, apart from the "retaining rings" themselves, which alone cost $53.68, and are all but indistructible, since they are subjected to no wear, and hence can be used again and again with successive engines or drivers.

As evidence of the extent to which tires break abroad there comes to our table as we write the last quarterly "Returns of Accidents and Casualties" to the Board of Trade of Great Britain for the quarter ending March 31, 1890. Turning to this at random, we find the following:

> Of the 181 tires which failed, 6 were engine tires, 3 tender tires, 2 carriage tires, 6 van tires, and 164 wagon tires. Of the wagons 124 belonged to owners other than the railway companies; 143 tires were made of iron and 8 of steel; 2 of the tires were fastened to their wheels by MANSELL'S patent method (that herewith illustrated); 3 by GIBSON'S method; 169 by bolts and rivets, 2 of which left their wheels when they failed, and 7 by other meth ods 12 tires broke in the rivet holes, 1 at the weld, 43 in the solid, and 122 split longitudinally or bulged, and 3 tires that failed did not break.

This is rather a small than large record, and for years experience has been rolling up at this rate all over Europe. It is, therefore, the height of folly for us in this country to insist on gaining this experience all over before we learn the lessen to be had from it, which is, that there is absolutely no method of securely fastening the tire to the wheel center except by the use of continuous retaining rings. Almost every conceivable form and combination of bolt and shrinkage fastening has been tried, but nothing proved successful until Mr. R. C. MANSELL, Carriage

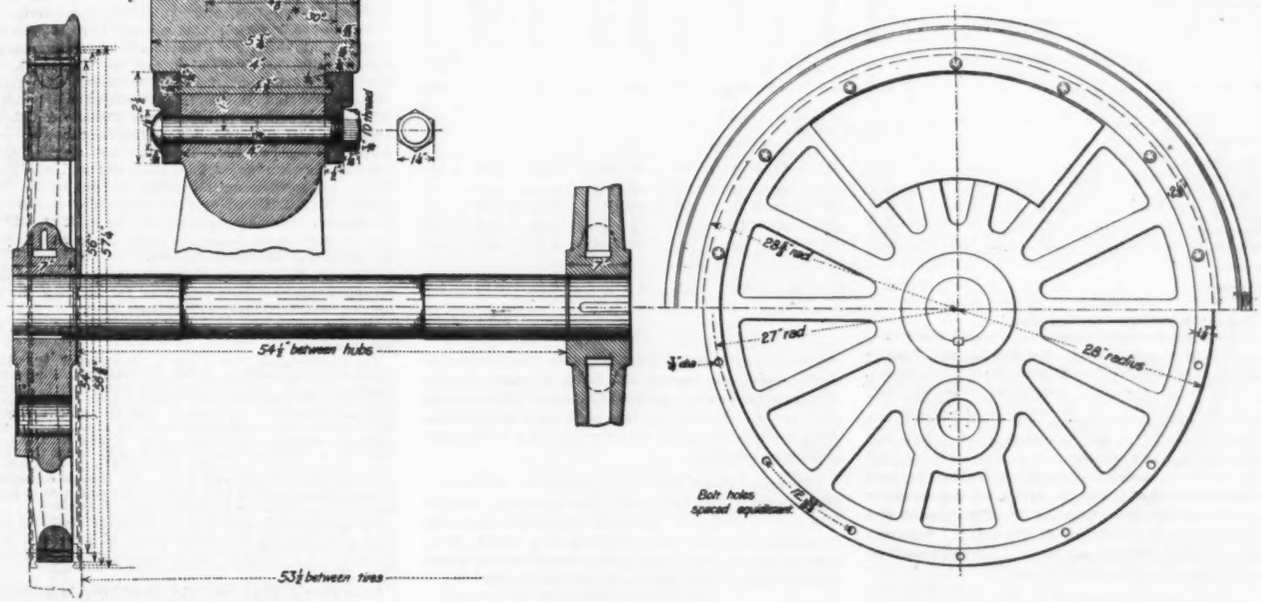
Superintendent of the London & Southeastern Ry. (if we remember correctly), devised, some dozen or fifteen years ago, the so-called "MANSELL retaining rings," shown in the accompanying illustration as applied to the standard driving wheel of the Lake Shore & Michigan Southern Ry., which was the second road in the country to adopt them as a standard, the Boston & Albany having done itself honor by being the first.

The extent to which this device is used abroad must not be inferred from the limited number recorded above found among the *broken* tires. Among the better and more important classes of vehicles its use or that of some equivalent is becoming all but universal, both for locomotive and car wheels. *Not a single instance is on record in which any part of a broken tire fitted with these retaining rings has left the wheel*, although in several instances the tire has broken into several pieces. The GIBSON fastening, which appears above, is a mere modification of the MANSELL, differing chiefly in the mode of fastening the rings, which is by hammering over a small lip turned on the tire instead of by bolts. This was by many thought an improvement, and at first sight it seems to be such. It has been used to some extent for locomotive drivers in this country, and if any one desires we shall be pleased to publish a cut of it; but the consensus of opinion seems to be that the plain Mansell type is the best of all, and certainly it is the simplest. To remove the GIBSON rings the wheel has to be put in a lathe and the lip turned off; but this is quickly done, and the ring is then as good as before.

A very important feature in regard to the economy of using these rings is that it will give at least a half-inch more of safe wear out of every tire. There is no reason why a tire should not be turned down to even 1¼ in. or less on its final turning, for even the fastest service, if it shows no signs of failure or loosening, whereas in the best practice now, it is not customary to turn tires down to less than 2 ins. for a final turning for very fast service, and in our judgment it should not be done for any kind of passenger service, as it is running a needless risk for a very small economy. No road that we know of turns below 1⅛ ins. and few below 1¾ ins. for fast passenger service.

The nature of the device is shown so clearly by the accompanying engraving as to require no further explanation beyond what is contained in the following quotation from a letter of Mr. GEO. W. STEVENS, Supt. of Motive Power, L. S. & M. S. Ry., transmitting the blue print from which our engraving is prepared:

> I take pleasure in mailing to you to-day blue print, illustrating the MANSELL retaining rings as applied to the locomotive driving wheels of this company, the cost of which per engine of four driving wheels is $73.17; $53.68 of this amount, however, would not appear after the rings were first applied, as the rings are good for an indefinite



STANDARD 56-IN. DRIVING WHEEL WITH MANSELL RETAINING RINGS, L. S. & M. S. R'Y. G. W STEVENS, SUPT. M. P.

service; in other words, they can be applied repeatedly from time to time as new tires are required.

It is our practice to confine the use of these rings to air brake engines, and, with this class of service, I should judge that your estimate of fully one-half inch as a difference for equal safety between tires equipped with rings and those without, would be a fair estimate of their effect in prolonging the life of the tire

Without having any practical experience as to the behavior of tires broken in service, and equipped with rings, I fully believe that the tire would rigidly adhere to its place, and that the engine would proceed on her journey without delay.

As regards other roads besides our own in this country using retaining rings, the Boston & Albany, I think, was the first; and, if I remember correctly, they apply them to all engines irrespective of service, and the Grand Trunk in the past few years has commenced using the rings, in consequence of breaking a driving-wheel tire and derailing train on bridge, causing great loss of life and injury, the facts as to which accident, I think, you must be familiar with.

In regard to the boiler explosion illustrated in our issue of June 7, Mr. STEVENS adds:

> I have been unusually interested in the reading of an account in your excellent paper of a boiler explosion in Norway, and agree with you that it is the most extraordinary on record. The position of the engines, I believe, has no parallel, except on the New York Central a few years ago, where an engine came in collision with a snow plow, and mounted the engine pushing snow plow, and took position on top of boiler, about the same as that of the boiler explosion in Norway. But this was not from a boiler explosion.

Elements of Weather in the United States, of Most Interest to Engineers, for the Month of June, 1890.
[Furnished to ENGINEERING NEWS by the Chief Signal Officer, U. S. A.]

STATION	Temperature. (Deg. Fah.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Maxim.	Direction at time of max. velocity.	Precipitation.—Rain and melted snow. Inches. Total.	Heaviest in 24 hours.	Number of rainy days.
NORTHERN CITIES.										
Northfield, Vt	61.0	83	36	47	8.9	36	N	2.84	1.14	12
Portland, Me	61.0	87	46	41	8.3	27	NW	4.53	1.32	9
New York City	70.0	89	55	34	9.0	38	W	4.19	1 47	9
Pittsburg, Pa	73 5	92	47	45	3 6	35	SW	3.37	1.24	13
Chicago, Ill	70.2	92	52	40	12.8	53	SW	3.25	1.03	12
Omaha, Neb	74.4	98	52	46	8.4	38	E	5.04	1.85	12
St. Paul, Minn	69.8	94	51	43	6.6	37	SW	5.29	0.97	18
Duluth, Minn	57.5	91	41	50	5.2	34	NW	3.33	1.39	13
Bismarck, N. Dak	66.9	91	46	45	11.5	32	SE	8.40	1.95	18
Average	67.1	90.8	47.3	43.5	8.3	38.9	.....	4.47	1.37	12.9
SOUTHERN CITIES.										
Washington City	75 0	92	50	42	5.0	36	S	2.02	0.76	9
Louisville, Ky	78.8	98	60	38	6.8	39	NW	6.96	1 65	13
St. Louis, Mo	79 4	98	57	41	10.5	38	W	3.18	0.83	11
Savannah, Ga	80.9	90	72	18	4.9	35	NW	4.38	1.24	10
Leavenworth, Kan	77.2	97	51	46	6.6	30	NW	1.93	1.03	5
Jacksonville, Fla	81.8	97	66	31	6.7	32	NE	1.80	0.80	14
Chattanooga, Tenn	78.9	95	73	22	4.3	22	SE	3.12	1.56	14
New Orleans, La	80.6	94	69	25	6.8	25	NW	7.71	3.08	14
Memphis, Tenn	80.6	96	63	33	5.8	50	SW	3.55	1.71	11
Palestine, Tex	78.2	94	56	38	5.6	23	SE	3.18	3.15	3
Average	79.1	95.1	61.7	33.4	6.3	33.0	.....	3.78	1 58	10.4
WESTERN CITIES.										
Helena, Mont	59.0	91	40	51	8.0	40	SW	1.83	0.60	19
Port Angeles, Wash	*	*	*	*	*	*	*	*	*	*
San Francisco, Cal	59.2	81	49	32	12.4	33	SW	0.10	0.05	2
Salt Lake City, Utah	64.9	89	58	31	5.0	36	W	0.32	0.30	3
Denver, Col	67.6	94	37	57	6.9	38	N	†	†	0
Yuma, Ariz	83.8	107	61	46	6.7	24	W	0.00	0.00	0
Santa Fé, N. Mex	64.7	88	36	50	7.0	36	SW	0.13	0.07	3
Average	66.5	91.3	46.8	44.5	7.7	34.5	.....	0.40	0.57	4.5

* Report not yet received. † Trace.

THE NEW YORK STEAM CO. has made a formal protest against the Board of Health's order obliging the closing of 4 sections of its mains. Besides the technical legal points made, it is claimed that the heat in the sewers is due to other causes than the steam mains. The company has been in business 8 years, and its mains have neither killed nor injured any person in that time. It is denied also that the mains cause injury to health. The business of the company now amounts to $2,000 a day. Between 3,000 and 4,000 buildings are heated, and 600 engines are run from the company's mains.

THE WESTINGHOUSE ELECTRIC CO., as noted last week, has increased its capital stock to $10,000,000. The company was organized in 1885 for the manufacture and sale of incandescent lighting apparatus using the continuous current. In the following year it took up the alternating system, which had not been considered commercially practicable, and thus entered a field entirely its own. In 1889 the sales of the company and its leased companies amounted to $4,302,115, yielding a profit of $729,307 after paying the heavy extraordinary charges incident to a new business of this character. For 3 years the company has been experimenting with electric railway appliances. No branch of electrical industry yields larger profits than this, and the company is now in a position to reap its share of these. Within 60 days the company has taken contract for 17 railways, aggregating $300,000 in value. An important achievement of the company in lighting is the establishment in London of the Metropolitan Electric Supply Co., Limited, which now operates a central station of 25,000 lights capacity, said to be the most complete and perfect central station in Europe.

THE STEEL ARMOR TESTS, to be made at Annapolis, Md., in August will be conducted with flat rectangular plates 8¼ ft. long, 6 ft. wide and 10½ ins. thick. A variation in the thickness of one-tenth of an inch will be allowed in order to cover inequalities of manufacture. The firms presenting the plates can bolt them to the backing in any manner they please, provided the total cross-section of the bolts does not exceed 58 sq. ins. and the number of bolts does not exceed 12. Five Holtzer chrome steel, ogival-headed projectiles, each weighing 100 lbs., are to be fired against each plate from a 6-in. rifle, with a striking velocity as near 2.43 ft. per second as possible.

THE LAKE FORK DRAINAGE DISTRICT, of Lincoln, Ill., has been organized under the drainage laws of Illinois, by authority granted by Judge INGHAM. It contemplates the construction of a ditch 20 ft. wide by 10 ft. deep, and the reclamation of 30,000 acres of land. The estimated cost is $150,000.

THE DIAMOND SHOAL LIGHTHOUSE CONTRACT has not yet been awarded, but it will probably be given soon. Although actual work can hardly begin before spring, nevertheless the successful bidder will be announced as soon as possible in order that the preliminary surveys and soundings, which will take some time, may be made this year.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Philadelphia & Reading.—Work on the terminal line at Harrisburg, Pa., is making rapid progress, and the company expects to have the line in operation before winter. Four of the 24 spans of the bridge across the Susquehanna River are completed and 11 more are now above water. A considerable portion of the masonry for the elevated structure through the city is finished and the grading from the west side of the river to Bowmansdale is about one-half completed. Plans for the new passenger station are being prepared.

Maine Central.—Work has been commenced and is making good progress on the extension of the upper Coös R. R. from North Stratford to Whitfield, N. H., a distance of 33 miles.

Central R. R. of New Jersey.—A press dispatch says:

The abandonment of the projected Jersey Central extension from Peapack, N. J., is rumored. The new line has already been surveyed and partly built. It was to follow the valley of the Passaic, run along the mountain ridge near the southern line of Summit Township, pass through Springfield and Irvington, and connect at Broad St., Newark, with the Newark & New York R. R. Such a road would develop a large extent of hitherto unimproved property and furnish quick transportation for residents of very desirable suburbs; but it is stated that the Jersey Central Company has come to the conclusion that the better policy will be to wait.

Deer Creek & Susquehanna.—It is stated that construction will be resumed on this Maryland road about August 1. The line is projected to run from Bel Air to Stafford, Md., 16 miles. George M. Jewett, of Glenville, Md., is President.

Ottawa & Gatineau Valley.—Work is progressing satisfactorily on this Canadian road. The line between Hull and Chelsea is already graded, and tracklaying will soon begin. W. D. Harris, 14 Metcalf St., Ottawa, Ont., is Chief Engineer.

Philadelphia & Seashore.—This road is now completed from Winslow Junction to Petersburg, N. J., and will be finished to Sea Isle City in about two weeks.

Lehigh Valley.—A press dispatch says:

The last spike in the new Lehigh Valley R. R connection between the Lehigh and Schuylkill valleys was driven yesterday at Renimont, West Penn Township, Schuylkill Co., Pa., in the presence of a number of prominent officals of the Lehigh Valley R. R. and invited guests.

Grand Trunk.—This company asks bids after July 23 for furnishing all the refined bar iron used by the company from Sept. 1, 1890, to June, 1891, the estimated quantity being 200 tons per month.

Ulster & Delaware.—It is probable that construction will soon be resummed on the extension to Oneonta, N. Y. Nearly all of the grading has been completed and a portion of the rails is on the ground.

Cape Breton.—This road will be completed for traffic by Aug. 1. It runs from Port Tupper, on the Strait of Canso, to a point near Leatch's Creek, 78 miles, with two branches from Leatch's Creek to Sydney and North Sydney, 13½ miles long and 5 miles long respectively.

Baltimore & Ohio.—This company in making its new entrance into the city of Chicago will leave the main line about 3 miles east of Whiting, and run due north over the Chicago & Calumet Terminal to East Chicago, thence to Hammond, Ind., Dalton, Ill., Riverdale and Blue Island. At the latter point it will leave the Chicago & Calumet Terminal, and run over a new line, the constructipn of which will begin at once. This new line, starting about midway between the Stickney tract and the Union Stock Yards, will go north until it strikes the line of the Wisconsin Central, thence over the latter into the Harrison St. Station. The new entrance of the B. & O. will be two or three miles longer in the city limits than its present route over the Illinois Central.

Chicago, Kalamazoo & Saginaw.—It is stated that arrangements have been completed for building the extension from Woodbury to Portland, Mich.

Philadelphia, Newtown & New York.—A press dispatch says:

The Philadelphia, New York & Newtown R. R., which was never completed, is now to be extend to such a connection with the Reading lines that trains may be carried to Ninth and Green Sts. and ultimately to the Reading's proposed terminal. An issue of $880,000 additional stock has already been authorized, and the stockholders will probably authorize a similar issue of bonds. The company has a charter giving it the right to bridge the Delaware River above Trenton, N. J., and will probably be extended some day to New York. The present extension, though this purpose is kept in view, is made now to bring fine sites for suburban residences into the market.

Philadelphia & Reading.—It is stated that this company is considering the construction of a branch from Elwood, N. J., through May's Landing to Ocean City, N. J.

Lake Erie & Western.—The report is again in circulation that this company will build a line from Minister to Pequa, O., about 20 miles.

Wabash.—The surveys are reported completed for the western extension of this road to Chicago, and the line, it is stated will be built soon.

Projects and Surveys.

Bristol.—The contract for building this Vermont road has been let to Geo. A. Ayer, of St. Albans, Vt. Work will begin at once.

Rome & Carthage.—It is stated that the necessary right of way has been secured and that the company now has under consideration proposals for the construction of this road. The company was chartered in 1888 to build a railway from Rome to Carthage, N. Y., a distance of 70 miles. A. C. Kissenger, of Rome, N. Y., is interested.

Providence & Springfield.—The surveys for this road have been completed. The road is projected to run from Providence, R. I., to Springfield, Mass.

Fitzwilliam & Southbridge.—Surveys are reported in progress for a railway from Fitzwilliam, N. H., to South bridge.

Northern Canadian Atlantic.—It is announced that engineers will soon begin the survey of this road. The line is to run from Quebec, P. Q., across the Saguenay district to a point on the Labrador coast, probably St. Charles Bay.

Pennsylvania Mutual.—Chartered in Pennsylvania to build a railway through Monroe and Lackawanna Counties, a distance of 50 miles. The road will run from a point on the Delaware River near Stroudsburg to a point on the Lackawanna River near Scranton. The Pennsylvania Midland R. R. Co. was chartered a short time ago to build a road over the same route.

Ferney Mountain.—Chartered in Pennsylvania to build a railway from Ferney to Waterville, Pa., 21 miles. Daniel Shepp, of Tamaqua, Pa., is President.

Gunpowder Valley.—Proposals will be received by

John B. Brown, Secretary, Room 17, 11 So. Gay Street, Baltimore, Md., for building this road.

Washington County.—It seems probable that work will soon begin on this road. The company, it is stated, has secured control of the Greenwich & Johnsonville R. R. and will extend it through the slate and limestone region to West Rutland, Vt. The length of the road will be about 56 miles and it is estimated to cost $30,000. It is stated that work will commence at once.

Louisville, Richmond & Dayton.—Chartered in Illinois to build a line of railway, from Louisville, Ky., to Dayton, O., a distance of 440 miles.

SOUTHERN—Existing Roads.

Albany, Florida & Northern.—Nelson Tift, of Albany, Ga., President, writes as follows:

This company was chartered to build lines of railway from Albany, Ga., to Augusta, Ga., with two branches from Albany to the Florida State line, one in the direction of Bainbridge and the other in the direction of Quitman. Surveys are now in progress between Albany and Cordele, 35 miles, and the contract for building this section has been let to the Albany Investment & Construction Co. There will be two bridges 100 ft. and 250 ft. long respectively. The principal business of the road will be in cotton, lumber, fruit, grain and general merchandise. W. W. Campbell, of Cordele, Ga., is Chief Engineer.

Alabama Midland.—Control of this road has been secured by the Plant Investment Co., and it will hereafter be operated in connection with the Savannah, Florida & Western R. R. It is stated that arrangements have been completed for an extension of the Montgomery, Tuscaloosa & Memphis, R. R., from Tuscaloosa, Ala., to Memphis, Tenn.

Atlantic & Danville.—It is announced that the capital necessary to build the Danville & East Tennessee R. R. has been secured.

Decatur, Chesapeake & New Orleans.—The contract for grading 20 miles of this road will be let at once. J. T. Crass, Decatur, Ala.

Macon & Dublin.—Chicago capitalists are stated to have secured control of this road and will, it is stated, complete it. The road was projected to run from Macon to Dublin, Ga., 40 miles, and a considerable amount of grading was done some time ago. Another report, which seems now probable, is that the Georgia Southern & Florida will make it a part of its line from Macon to the seaboard.

Chattanooga Southern.—W. C. Durand, of Chattanooga, Tenn., will sublet contracts for building 40 miles of this road.

South Bound.—The contract for constructing the section of this road from Savannah to a point north of the Savannah River has been let to Louis McLain, to be completed by Dec. 1.

Bristol, Elizabethtown & North Carolina.—Construction has been commenced on this road at Bristol, Tenn.

Morristown & Cumberland Gap.—Work has been commenced on this Tennessee road. Charles J. Allison, of Morristown, is chief engineer.

Wadley & Mt. Vernon.—Vice-President F. M. Fremont, of Atlanta, Ga., writes that it is the intention of this company to extend its line from Blackville to Mt. Vernon, Ga., where connection will be made with the Savannah, Americus & Montgomery R. R., but that owing to certain negotiations now pending for a different route the line has not been definitely decided upon. The general offices of the company are at Wadley, Ga.

Nashville, Chattanooga & St. Louis.—This company has advertised for bids for the construction of the extension of the Tennessee & Coosa R. R. from section 10 to section 34. The first 19 sections are to be completed by Jan. 1, 1891, and the remaining sections by May 1, 1891. Before the completion of this work the contract for the remainder of the road between section 33 and Huntsville, Ala., and possibly for the bridge across the Tennessee River will be let. Address R. C. Morris, Chief Engineer, Nashville, Tenn.

French Broad Valley.—James Raymond, of 45 Broadway, New York City, who has the general contract for building this road, has sublet 10 miles to A. B. Fortune, of Abbeville, N. C., 10 miles to Corpening & Lewis, of Asheville, N. C., and 27 miles to James D. Hardin, Columbus, N. C. The road is to run from Asheville south, to the South Carolina State line, 60 miles, with a branch from Mills River to Rutherfordton, 40 miles. The contract for the trestling, cross-ties and rails has been let to Gordon & Co. of New York City.

Projects and Surveys.

Harrisonburg & Western.—This company has been organized to build a railway in Virginia. J. P. Houch, of Harrisonburg, Va., is interested.

South Lake & Germantown.—This company has been organized to build a railway about 12 miles long near Charleston, S. C.

NORTHWEST.—Existing Roads.

Kickapoo Valley & Northern.—The contract has been let for constructing 50 miles of this Wisconsin road.

Indianapolis, Decatur & Western.—A meeting of the stockholders will be held soon to consolidate this company with the company organized to build the extension to Beardstown, Ill. Arrangements are now said to be completed for the construction of the extension.

Pacific Short Line.—This road has now been completed from Sioux City, Ia., to O'Neill, Neb., 128 miles.

Chicago & Northwestern.—Surveys are reported in progress for a line from Randolph, Neb., to Yankton, S. Dak. About 1,500 men are now working on the extension of the Freemont, Elkhorn & Missouri Valley R. R. from Whitewood to Deadwood, S. Dak. The greater portion of this force is at work on the tunnel near Whitewood cañon.

Forest City & Southeastern.—A press dispatch announces that tracklaying has been completed on this South Dakota road. The route is from Forest City to Gettysburg, S. Dak., 16 miles.

Projects and Surveys.

Niobrara & Sioux Reservation.—Sanford Horton, of Ogden, Utah, writes as follows:

This road is to run from Verdigris, Neb., to Niobrara, Neb., 12 miles. The road is over an abandoned roadbed of the Chicago, Milwaukee & St. Paul R. R., and the work will be very light. The surveys were completed in 1889. The maximum grade is 20 ft. per mile and the maximum curve is 3°. The principle business of the road will be in grain, cattle and cattle products, and farming machinery. About 75% of the right of way has been secured, and $8,000 in other local aid obtained. F. P. Bonnell is President.

Omaha, Superior & Southwestern.—The preliminary survey of this road has been completed from Superior, Neb., to Hays City, Kan., a distance of 118 miles.

Manitoba & Southeastern.—Alex. Stewart, of 178 Kennedy St., Winnipeg, Man., Chief Engineer, writes as follows:

This road is projected to run from Winnipeg, Man., to the northwestern angle of Lake of the Woods, and thence to the International boundary, a distance of 100 miles. The line has been located from Winnipeg to St. Anne, 30 miles, and 15 miles of the right of way has been secured. The work is generally light, maximum grade, 20 ft. per mile. The route is through a fine agricultural and timber section of the country. The company has a land grant of 6,400 acres per mile. Alex Logan, of Winnipeg, is President.

SOUTHWEST.—Existing Roads.

Corpus Christi & South American.—S. H. Mallory, of Corpus Christi, Tex., writes us that the contract has been let to the Iowa Southern Improvement & Investment Co. to build this road, which will be about 150 miles long. The maximum grade is 16 ft. per mile, and there are very few curves. Nearly all of the right of way has been secured, and valuable donations have been obtained from Corpus Christi and Brownsville, and the towns along the route. It is expected that tracklaying will begin in August, and the line completed in about a year. E. H. Ropes is President, and D. J. Thayer is Chief Engineer.

San Antonio & Aransas Pass.—This Texas road has been placed in the hands of a receiver.

Kansas City, Nevada & Ft. Smith.—General Manager, Richard T. Gentry, is quoted as saying: "The roadbed of the Kansas City, Nevada & Fort Smith is complete in Bates county with the exception of a little rock work to be finished the first week in August. The company will then begin laying tracks in Jackson county, and the road will be completed from Kansas City to Amoret by October 1. Tracklaying will be commenced in Jackson county at Grand View, near Hickman's Mills. The road will come in from that point to the Blue Valley over the Kansas City Southern temporarily. It will enter the city over the Kansas City, Suburban & Belt Line. The 'Belt Line' is practically owned by the same men as the Kansas City, Nevada & Fort Smith road."

Choctaw Coal & Railway Co.—Tracklaying is now in progress at El Reno, Ind. Ter. The line has been completed from McAlester to the St. Louis & San Francisco R. R., and will soon be put in operation.

Chicago, St. Paul & Kansas City.—The right of way has all been purchased on the line between St. Joseph, Mo., and Leavenworth, Kan., and grading is now in progress. It is expected to have the line completed in 60 days.

Kansas City, Watkins & Gulf.—Work is being steadily pushed on the line from St. Charles to Alexandria, La. Fifteen miles of track have been laid from St. Charles.

North Topeka, Rossville & Silver Lake.—This seven-mile railway running from North Topeka to Silver Lake, Kan., has been sold to the projectors of the Topeka, Westmoreland & Marysville R. R., and will be made a portion of that line from North Topeka, Kan., to Odell, Neb. Robert Giles, of North Topeka, is Chief Engineer of the T., W. & M. R. R.

Missouri Pacific.—Henry, Forrest & Co., of Room 54, Gay Building, St. Louis, Mo., will let the contract for 3,000,000 cu. yds. of grading, 2,500,000 ft. B. M. timber work, 150,000 lin. ft. piling, 250,000 cross-ties and 1,000 acres of clearing. This work is on the extension of the Houston, Central Arkansas & Northern R. R. from Monroe to Alexandria, La.

Projects and Surveys.

Texarkana & Denison.—It is announced that a company will be organized to build a railway from Texarkana, Tex., along the Red River to Denison, Tex. The route is through some of the finest timber lands in Texas.

Beebe, Des Arc & Brinkley.—Surveys are reported in progress on this road, which is projected to run from Beebe to Brinkley, Ark., about 50 miles. A. M. Burton, of Beebe, Ark., is interested.

ROCKY MT. AND PACIFIC.—Existing Roads.

Southern Pacific.—Nearly the entire amount necessary to secure the right of way for the branch from Martinez to Pleasanton, Cal., has been subscribed, and construction will begin soon.

Union Pacific.—The arrangements are nearly completed for building the line from Portland, Ore., to Tacoma, Wash., and the contracts for construction will be let in a short time. The line is 185 miles long, and will be completed as soon as possible.

Northern Pacific.—C. W. Greggs has the contract for building the 18-mile line from Durham, Wash., to the Raging River mining country. The contract for building the Lake Washington Belt Line has been let to Henry & Balch, of Minneapolis, Minn. Chief Engineer Kendrick states that the contract will be let immediately for the extension of the Washington Central R. R. to the Columbia River. The road is to be completed this season.

Canadian Pacific.—President Van Horne is reported as saying:

The Long Lake road will be completed to Prince Albert by September. Work has been commenced on the Calgary & Edmonton road, 100 miles of which will be completed this year. The only work which the C. P. R. itself has on hand in the Northwest is the extension of the Glenboro line, about 35 miles, the completion of the Souris branch to Melita, or a little beyond, and the construction of the Columbia & Kootenay road, to connect the Columbia River with the Kootenay Lake, and the Mission branch from the Mission, B. C., to a point 10 miles south, on the International boundary, to connect with a railway extending to Seattle and other Puget Sound points. All these works will be completed before winter. An independent company is constructing a line from the C. P. R. at the Sicamous Narrows to Okenagan Lake, which will open up a very important agricultural district in the heart of British Columbia.

Spokane Falls & Northern.—This line from Marcus to The Dalles, Wash., will be opened for traffic Aug. 1. The location has been completed to the International boundary. At Little Dalles the road will connect with a line of steamers running to Ravelstoke on the Canadian Pacific Ry. E. J. Roberts, of Spokane Falls, Wash., is Chief Engineer.

Projects and Surveys.

California Improvement Co.—This company has been chartered in Illinois to build a line of railway from San Francisco to Los Angeles, Cal. It is the intention of the company to purchase the Los Angeles, Pasadena & Glendale R. R., and make it a part of the New line. Among the incorporators are: Oliver J. Hastings, B. F. Hobart, Geo. W. Parker and others.

Lake Washington Belt Line.—Chartered in Washington to construct railways, water-works, electric light plants, etc. Incorporators, L. S. J. Hunt, Jacob Furth, A. S. Dunham, J. F. McNaught, Jas. McNaught.

CITY TRANSIT.

Dummy Railway.—***Greenville, S. C.,*** has appointed a committee to prepare plans for a line.

East Portland, Ore.—The lines will be extended 2 miles during the summer.

Cable Roads.—***New York, N. Y.***—Plans of the changes on the Third Ave. line have been filed with the Public Works Department. The U. S. Government has given its consent to the use of cables on that part of Broadway in front of the national property.

Los Angeles, Cal.—A road is proposed.

Elevated Roads.—***Brooklyn, N. Y.***—The proposed Atlantic Ave. elevated lines have offered to carry local passengers for 5 cents and transfer all persons between Fulton Ferry and the Union Elevated station free of charge, if given a charter.

Chicago, Ill.—A 2 or 3 track line is proposed on the West Side. The plans are now before the City Council.

Horse Railways.—Proposed at Westfield, Mass.; Allegheny, Pa.; Alexandria and Kentwood, La.; Green Bay, Wis.; Weiser, Idaho.

Ocean Grove, N. J.—The line from this place to Shark River will soon be begun.

Hope Mills, N. C.—Proposals for a 13 mile line will be wanted shortly by the Enterprise Land Co., of Fayetteville, N. C.

Centralia, Wash.—A 4 mile line is being surveyed.

Electric Railways.—Electricity has been adopted as a motive power on the lines at St. John, N. B.; Pittsfield, Mass.; Buffalo and Troy, N. Y.; Newark, N. J., and Grand Rapids, Mich.

New Lines will be built at St. John, N. B.; East Aurora, N. Y.; Pittsburgh, Pa.; Montgomery, Ala.; Knoxville, Tenn.; Cairo, Ill.; Moberley and Lebanon, Mo.; O'Neil, Neb.

Extensions of existing systems are proposed at Knoxville, Tenn.; Louisville, Ky.; Lansing, Mich.; Helena-Moat.; East Portland, Ore.

Brooklyn, N. Y.—The line contemplated on Montague St. is attracting considerable attention since the grades are much heavier than have as yet been used. The storage battery system will be used. The Coney Island & Brooklyn R. R. has applied for permission to change from steam to electricity as a motive power.

New Companies.—Aurora, N. Y., Street Ry., Light & Power Co., capital stock, $10,000; incorporators, B. W. Dodson, D. J. Hogan, M. C. Orlon. Metropolitan Electric Ry., Chicago, Ill.; capital stock, $5,000,000; incorporators, L. Fox, M. Brand, H. Vollmer. Joplin, Mo., Electric Ry. & Motor Co.; capital stock, $100,000; incorporators, J. C. Stewart, J. N. Bofinger, B. F. Hammett. Tacoma, Wash., Belt Line R. R.; capital stock, $500,000; incorporators, I. W. Anderson, O. B. Hayden and others. Yakima, Wash.,

Street Ry. & Power Co.; capital stock, $100,000; incorporators, W. Ferguson, M. V. Massey and L. MacLean.

HIGHWAYS.

Rhode Island.—The residents of Bristol and Warren are making strong efforts to have the highways in their neighborhood improved.

Oregon.—A highway will be built between Astoria and Tillamook.

BRIDGES, TUNNELS AND CANALS.

Bridges.—***Boston, Mass.***—Proposals for building the Federal St. bridge will be received until July 21. William Jackson, City Engineer, City Hall, Boston.

Buffalo, N. Y.—Chas. E Williams has the contract for the bridge across Seajaquada Creek at $23,490.

Fultonville, N. Y.—The contracts for building the bridge over the Erie Canal have been let to Isaac Thomas for the substructure, $3,532, and to the Rochester Bridge Works for the superstructure, $4,359.

Johnstown, N. Y.—A bridge will be erected over Cayadutta Creek, on Washington St.

Rochester, N. Y.—A seven-span, riveted plate girder bridge will be built at this place. The structure is to cost $160,000.

New York, N. Y.—The following bids were received on July 1 for the improvement of 155th St. from St. Nicholas Ave. to MacComb's Dam Bridge. Each bidder was required to give bonds for $100,000, with a $5,000 deposit, for the completion of the work in 500 days.

	4,750 cu. yds. Rock Excavation.	7,500 cu. yds. Earth Excavation.	10,000 cu. yds. Filling.	2,500 cu. yds. Dry Masonry.	700 cu.yds.Com. Cement Concrete.	3,300 cu. yds. 2d class Ashlar Masonry.	1,650 cu. ft. Granite Coping.	630 cu. ft. Granite Steps, etc.	225 M. ft. B. M. Timber.	2,003 Piles.	2,680 cu. yds. Portland Cement and Concrete.	1,974 cu. ft. Granite Coping.	112,000 lbs. Castings.	1,000 lbs. Anchor Bolts.	7,500,000 lbs. Metallic Structure.	1,200 cu. yds. Bituminous Concrete.	8,618 sq. yds. Granite Paving.	4,362 sq. yds. Asphalt Sidewalk.	3,760 lin. ft. Gutter Stone.	570 lin. ft. Stairway, etc.	1,700 sq. ft. Platform.	3,400 lin. ft. Iron Railing.	80 Cast Iron Newels.	40 Cast Iron Lamps and Posts.	8 Cluster Lamps and Posts.	3,500 lin. ft. Gas Pipe.	12 Drainage Gratings.	800 Wt. Iron Leaders.	3,760 lin. ft. Gutter Stone.	Total Bids.
	$	$	$	$	$	$	$	$	$	*	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	
M. S. Coleman	2.50	1.00	0.75	4.00	6.00	10.00	2.50	3.00	0.40	12.00	10.00	2.50	0.01¾	0.03	4.35	15.00	3.50	2.50	1.00	27.20	5.85	4.25	7.00	30.00	75 00	0.65	50	2 00	1.00	584,123
Mahoney Brothers	1.75	1.00	0.25	2.90	4.75	7.20	2.50	3.50	0.36	8.50	10 57	1.50	0.04 2-10	0.04 2-10	4 2-10	5.70	3.95	1.43	0.65	16.00	3.50	3.70	9.00	25.00	100.00	0.25	20	1.20	0.75	520,661
*Herbert Steward	1.15	0 96	0.35	2.95	5.50	8.00	2.10	1.90	0.40	12.00	8.25	1.45	0.04	0.04	4.00	11.50	3.00	1.60	0.45	27.20	3.85	4.25	7.00	30.00	75.00	0.65	50	2.00	0.40	514,423
J. J. Hopper	1.69	1.69	0.01	2.73	5.25	9.40	2.60	2.25	0 43	11.50	9.62	1.82	0.02 1-10	0.03¼	3 9-10	7.50	4.00	1.82	0.72	21.53	3.00	3.96	3.50	16.50	82.50	0.26	15	1.06	0.96	518,198
Keystone Bridge Co.	2.00 / 4.00	0.30 / 0.40	0.25	4.00	5.00	9.00	2.00	2.00	0.30	11.00	9.00	1.50	0 02¼	0.03½	4.495	15.00	4.00	1.80	0.60	27.20	3.85	4.25	7.00	30.00	75.00	0.65	50	2.00	0.70	568,360

* Awarded the contract.

Cincinnati, O.—Civil Engineer J. A. Stewart has prepared the plans for the Eighth St. viaduct. The length of the structure will be 2,936 ft., and its estimated cost is $280,000, of which amount $130,000 will be expended on the substructure.

Chicago, Ill.—The Kenwood Bridge Co. has been chartered to manufacture and sell iron and steel bridges. F. W. Baker, Paul Willis, and G. W. Murry are the incorporators, all of Chicago.

Nebraska City, Neb.—Nebraska City and precincts have voted $100,000 in bonds to the Phœnix Bridge Co. to aid in building the bridge across the Missouri River. Work will begin at once.

Burlington, Ia.—The Chicago, Burlington & Quincy R. R. Co. has completed the details for the erection of a double-track railway bridge over the Mississippi at this point, to take the place of the old structure. The work will begin at once. The new structure will be built on the site of the old one, which will be gradually torn away as the work goes on without interfering with railroad traffic. Three spans are to be finished by winter.

Brownsville, Tex.—The Continental Bridge Co. has been chartered to build a bridge across the Rio Grande River at this place. Felician San Roman, of Brownsville, is President.

Tunnels.—***Colorado Midland Ry.***—The contract for constructing the 9,350 ft. tunnel through the Continental divide will be let soon. Further particulars will be found in our "Engineering News" columns.

WATER-WORKS.

NEW ENGLAND.

Augusta, Me.—The water company is to build an extension to the pumping station.

Bar Harbor, Me.—It is reported that M. M. Tidd, of Boston, has been engaged by the Eden Water Co. as consulting engineer on the question of putting in a new system of works.

Goffstown, N. H.—The estimated cost of the new works is $30,000. D. A. Taggart and S. Upton have charge of the matter.

Rutland, Vt.—The commissioners have purchased property for an additional storage reservoir, to have a capacity of about 5,000,000 galls.

Braintree, Mass.—The town has voted to complete the new works.

Chicopee Falls, Mass.—Superintendent Stickney is reported as stating that about $3,000 will be expended next season for improvements.

Chicopee, Mass.—The water supply is reported inadequate, and steps will probably soon be taken to increase it. It is reported that the present supply can be trebled by building a dam 1,800 ft. below the present one on Dingle Brook and establishing a pumping station there.

Springfield, Mass.—Sealed proposals will be received by the Board of Water Commissioners until July 24 for the work to be done on the improvement of the water supply. It will consist of about 4 miles of canal work, head-gates, masonry, dams, pipe lines, etc. Address H. Q. Sanderson, Chairman Water Commissioners.

Great Barrington, Mass.—The water committee has engaged Prof. D. M. Green, of Troy, N. Y.; Mr. Goodhue, of Springfield; Percy M. Blake, of Hyde Park, to act as experts and examine the respective plants of the two water companies.

Washington, R. I.—A water supply is to be put in by the Warwick & Coventry Water Co. Address John J. Arnold, President, Phenix, R. I.

Providence, R. I.—City Engineer Shedd's plans for improving the Fruit Hill reservoir have been adopted They are as follows:

Uncovering the inside of the reservoir to the ledge, stopping the fissures as far as practicable, relining the entire reservoir. Estimated cost, $75,000.

Norwalk, Conn.—An appropriation of $30 000 has been made for replacing the present mains with larger sizes.

Norwich, Conn.—An engineer is to be employed to submit an estimate on July 28 of the cost of repairing the bank of Canaswatca Creek to prevent another overflow.

MIDDLE.

Delhi, N. Y.—A petition has been presented to the company asking for a better water service.

New York, N. Y.—The new aqueduct was opened on July 15 to fill the Central Park reservoir. It will be opened again for continuous use in about six weeks.

Hewlets, L. I., N. Y.—The Hempstead Township Water Co. has filed a certificate of organization with the Secretary of State. Capital stock, $20,000. The Trustees are: John Lockwood, John C. Lockwood and George W. Lockwood, of Jamaica; D. D. Williams, of Haverstraw; Frank G. Lockwood and Paul Campaignac, of Brooklyn, and Samuel A. Souther, of Bay Shore.

Penn Yan, N. Y.—The citizens have voted adversely on the question of allowing an outside company to put in works. The citizens desire to have works, and it is probable that a home company will be organized. The question of the town building and owning the plant is being considered.

Syracuse, N. Y.—Judge Churchill has vacated the injunction restraining the city from issuing bonds. He also decides favorably for the city all points affecting Skaneateles Lake as a source of supply.

East Aurora, N. Y.—The citizens have voted to have a system of works put in. Propositions will be received.

Rochester, N. Y.—Sealed proposals will be received until July 25 for a 2,000,000-gall. pumping plant. Bids for laying a considerable mileage of new mains as per specifications will be received on July 21. Reports have been submitted by Engineers Tubbs and Rafter recommending the use of the Gates well and the sinking of one or two additional wells. The reports also include analyses of various waters by Dr. Lattimore.

Brooklyn, N. Y.—The Long Island Water Supply Co. has obtained an order from Judge Cullen restraining the Commissioner of City Works from laying water pipes in any part of the 26th Ward. The city will assert that, as the Truant's Home is a city building, it has a right to supply it with water.

Madison, N. J.—The pumping plant is to be located at Union Hill. Bonds for $60,000 will be issued.

Burrell, Pa.—Regarding reports that works were to be built at this place, we have received the following information:

There are no works at Burrell, but a charter has been taken out for the Burrell Water & Gas Co. at Parnassus, Pa., 5 miles below Burrell.

Allegheny, Pa.—Henry Dauch & Co. have been awarded the contract for drilling and casing an artesian well. A petition has been received by the City Council from Samuel Harris asking for the privilege of digging four large wells for supplying pure water for domestic use.

Hughesville and Picture Rocks, Pa.—R. Harvey Welch, Secretary, has sent us the following information:

Contracts will be let by the Hughesville Water Co. as soon as the right of way has been secured. Water will be furnished by gravity from Roaring Brook. Probable cost, $30,000; $16,000 has been secured; bonds will be issued for the remainder. President, J. K. Rishel. Population, 2,000.

Cumberland, Md.—A report recently submitted to the City Council by the Committee on Water-Works recommends the laying of a considerable amount of new 6-in. mains.

Washington, D. C.—Col. George H. Elliott has submitted his annual report. He recommends that, inasmuch as filtering the entire supply would be too expensive, an additional settling basin be constructed for removing sediment from the Potomac River water. He further states:

The receiving reservoir is suited for settling purposes if all the water be excluded from it except the water from the Potomac and the margins deepened and protected. I recommend the adoption of the project of Capt. Symons, submitted in 1885, to conduct the waters of the several small streams now flowing into the reservoir through paved channels around the slopes of the reservoir into Little Falls branch. This is to be done by building small dams across the mouths of the streams below the points where the artificial channels enter and leave the basins. By this plan the receiving reservoir would then become a distributing reservoir, and the time for the settling of the water would be considerably more than double that now allowed. Capt. Symon's estimate of the cost of excluding the water of the surrounding country from the receiving reservoir, including the purchase of the small amount of land required and the cost of completing the fencing of the reservoir land, was $123,000. To obviate the defects of the reservoir caused by shoal water I would deepen the water everywhere at its margin to 12 ft., and protect the sides by slope walls of dry rubble stone 12 ins. thick, laid upon a lining of broken stone 6 ins. thick, at the following estimated cost: 148,300 cu. yds. of excavation at 35 cts.; 16,400 cu. yds. dry stone masonry, at $4.50; 8,200 cu. yds. broken stone lining at $2.50; 10% for contingencies, making the grand total $284,625.

As an additional step Col. Elliott recommends the lowering of the cross dam at the distributing reservoir in order to allow a more perfect mixing of the water, which would cost $12,500.

The contract for furnishing the district with 75 fire hydrants has been awarded to Edward L. Dent, at $55.95 each; also for furnishing the district with 50 street hydrants, at $5 each. A 3-in. main will probably be laid to supply the Department of Agriculture with water.

SOUTHERN.

Hinton, W. Va.—Bids will be received until August 1 by E. R. Van Antwerp, President Hinton Water-Works Co., for the erection of a system of works.

Wheeling, W. Va.—The Water Board urges the removal of the intake pipe to a point free from sewage contamination. The *Register* states: We must have better and purer water.

Macon, Ga.—S. R. Jacques, William H. Ross, J. T. Hanson, and other business men have applied for a charter for a water company to put in works and will commence the construction of works as soon as it is granted. Capital stock $100,000, with the privilege of increasing it to $500,000; 10% is reported to have been taken. The right of way for pipe lines and Swift's Creek as the source of supply have been secured. Another report states that Col. George F. Work, Secretary of the old company, is about to make general improvements and increase the daily supply to 3,000,000 galls.

Griffin, Ga.—The Griffin Water & Light Co. has been organized by W. A. and J. F. Robinson and W. A. Bedell.

McDonough, Ga.—The following information has been received from H. B. Neal:

It is not probable that any works will be built at present, but if any steps are taken the work will be carried on by a company. H. J. Copeland can furnish information. Water would probably be pumped from a spring to a tank.

Savannah, Ga.—James Mulligan has been awarded the contract for sinking two 8-in. artesian wells.

Ocala, Fla.—A vote will be taken on Aug. 14 on the question of issuing $100,000 of bonds for purchasing the existing works from the Ocala Water Co.

Alexandria, La.—A water and electric light company is to be organized.

Knoxville, Tenn.—Superintendent C. F. Wood is reported as making the following statement:

The town has outgrown the present plant, and definite arrangements are now in progress to secure a plant necessary to furnish all the city with water. There will be an enlargement and overhauling of the present system in the near future.

Nashville, Tenn.—Bonds for $200,000 will probably be issued.

Winchester, Ky.—Wheeler & Parks, of Boston, Mass., have accepted the proposition of the City Council, and will at once begin the erection of works, which must be finished in 10 months.

Ashland, Ky.—Gardner & McGlasson, of St. Louis, Mo., were awarded the contract by the City Council for putting in a complete system of works on July 10, to be completed by Jan. 1, 1891.

Somerset, Ky.—Chairman A. M. Parsons has kindly sent us the following information:

The contract for works let on June 22 to the Kentucky Illuminating, Heating & Water Co., of Lexington, Ky., has been ratified by the City Council. John A. Geary, of Somerset, Ky., is the Manager.

NORTH CENTRAL.

Coshocton, O.—Contracts have been awarded as follows: Valves, Rensselaer Mfg. Co., Troy, N. Y.; hydrants, (100) Bourbon Copper & Brass Works, Cincinnati, O.; pipe, Lake Shore Foundry, Cleveland, O.; pipe-laying, Ruyder & Williams, Dayton, O.

Cleveland, O.—The Variety Iron Works has been awarded the contract for furnishing 600 ft. of 40-in. wrought-iron pipe for the tunnel under the Cuyahoga River, at $19,0 0.

Goshen, Ind.—Sealed proposals for a 1,500,000-gall. duplex pump, heater, feed pump, etc., will be received by Superintendent Lew Wanner until August 4. Specifications can be secured from W. R. Ellis.

Huntington, Ind.—Bids for furnishing pumping machinery, pipe, hydrants, valves, etc., will be received until July 29 by William McGrew, President Water-Works Mfg. Co. John W. Hill, of Cincinnati, O., is the Consulting Engineer.

Owosso, Mich.—The city has accepted the bid of W. R Coats for improving the works. The contract price is $20,000.

Ludington, Mich.—G. G. Wing, President Water Supply Co., has sent us the following:

The intake pipe is to be projected into the lake one mile. A 20 or 24-in. main will be used. Correspondence with contractors is solicited.

Lansing, Mich.—Sealed proposals will be received until Aug. 1, for $25,000 of 4½% 30-year bonds, by William C. Hinman, City Clerk.

Harvard, Ill.—The Harvard Water-Works Co. has been incorporated to construct and maintain works. Capital stock, $15,000. The incorporators are: Henry A. Keith, Mark A. Thompson and James T. Hosford.

Alpena, Mich.—The contamination of the water supply with sewerage is being discussed.

Muskegon, Mich.—Bids for making the proposed improvements will be received by A. V. Mann, President Board of Public Works, until July 21. Chester B. Davis, of Chicago, Ill., is the Consulting Engineer.

Madison, Ill.—(A new town, probably near Edwardsville, Ill.)—The Madison Construction Co. has filed articles of incorporation. Its object is to construct gas, electric light, power and water-works, etc. Capital stock $25,000. The incorporators are Eben C. Robinson, J. H. Mackie and Christian Bernet.

Centralia, Ill.—It is now proposed to construct works for fire protection and manufacturing purposes. The supply furnished by the Illinois Central R. R. has become inadequate, and it is probable that some steps will soon be taken.

Harvard, Ill.—The Western Construction Co., of Chicago will build the works at this city. W. R. Coats, of Owosso, Mich., has been engaged to develop the water supply and put down one of his reservoir wells.

Summit Lake, Wis.—W. R. Coats, will prepare plans and estimates for a type of his reservoir well, 50 ft. deep by 20 ft. in diameter.

Oshkosh, Wis.—Consulting Engineer John W. Hill, of Cincinnati, O., who has been engaged by the company to superintend the improvements, has sent us the following:

The improvements will consist in abandoning the present artesian wells, which are insufficient to meet the current demands, and the water from which is hard enough to unfit it for many uses, and taking all water from Lake Winnebago; this to be filtered before it is pumped for consumption.

The water of Lake Winnebago is more desirable than the deep well water for domestic and manufacturing uses, but in its natural condition contains too much fine silt and peaty matter for drinking and culinary purposes. The objectionable matter, however, is not dangerous in character and will yield to the operation of sand filters.

NORTHWESTERN.

Hampton, Ia.—Charles Kray, Recorder, has sent us the following information:

The special election on July 7 resulted in a large majority vote being cast in favor of issuing bonds for constructing works. No plans have been adopted as yet and no engineer has been engaged.

Algona, Ia.—Bonds for $10,000, for a system of works, will be issued as soon as water from an artesian well is secured.

Sioux City, Ia.—Spencer & Peitock have been awarded the contract for putting down a well at the pumping station.

Duluth, Minn.—An ordinance has been passed granting the Duluth Gas & Water Co. authority to lay mains to West Duluth and supply the town with water.

Argentine, Kan.—Woodbury & Moulton, of Portland, Me., are offering $75,000 of 6 per cent. first mortgage 20-year bonds for sale.

Abilene, Kan.—Extensive improvements are contemplated.

Fort Russell, Wyo.—The new works have been formally accepted. Keefe & McGarvey were the contractors. Cost, $43,000.

Billings, Mont.—The Buffalo (N. Y.) Steam Pump Co. will furnish the pumping machinery for the new works.

Great Falls, Mont.—The contract for excavating for the 2¼ miles extension of the mains has been awarded to Tuck & Huelster.

Miles City, Mont.—Five more wells are to be put down; five have been completed.

SOUTHWESTERN.

Lexington, Mo.—The Lexington Water Co. proposes to extend its mains to Higginsville, 13 miles distant. General improvements for better fire protection will be made.

Sulphur Springs, Tex.—Kellogg & Thompson, of Denison, Tex., are the contractors for the new works.

Galveston, Tex.—An experimental deep well is to be sunk to a depth of 2,500 to 3,000 ft. The estimated cost to a depth of 2,500 ft. is $25,000. If this well proves successful, additional wells will be sunk. If not, authority will be asked of the Legislature to issue bonds for bringing the supply from the mainland.

Pueblo, Col.—The Pueblo Water Gravity Co. has been organized by L. R. Ehrich, Frank White, J. A. Hayes, Jr., and others. Excavations to bed rock at Fountaine Qui Bouille, 14 miles distant, have been made, and a small temporary dam built 40 ft. below the surface to impound the underground waters. It is estimated that a daily flow of 1,000,000 galls. has thus been secured. Work on a larger dam is to be commenced at once. Pipe is to be laid from the dam to North Pueblo Heights and other additions north of the city, and the company will make a proposition to supply Pueblo with water.

Santa Fé, N. M.—At a recent meeting of the Santa Fé Water & Improvement Co. the following Board of Directors was elected: R. F. Carr and Thos. E. Tutt, of St. Louis; R. J. Palen and L. Spiegelberg, of Santa Fé. Mr. Carr stated that the company has in view some important changes in the water service.

PACIFIC.

Pine Forest, Wash.—The Pine Forest Water Co. has been incorporated. Capital, $11,000.

Hoquiam, Wash.—John Richardson, Chairman Committee on water, fire and light has sent us the following:

The present supply is from a spring, but is inadequate. The plan proposed at present is for the city to issue bonds and build its own works. Authority has been secured to issue bonds for 2-5 of the town's assessed valuation for this purpose. No surveys have been made, and no plan has been positively decided upon, but it is probable that water will be pumped to a stand-pipe. The proposed source of supply is 4 to 6 miles distant. Works must be constructed, and if the town is unable to place its bonds, a franchise will be granted to a private company.

Seattle, Wash.—The following recommendation has been made by the Fire and Water Committee:

That a 1,250,000 gall. pump be ordered from Henry R. Worthington, of New York, at once; also, that 18 hydrants be set on the Yesler Ave. mains.

Ritzville, Wash.—Works are to be established.

Goldendale, Wash.—The town will issue $12,500 of 20-year bonds.

Chehalis, Wash.—Steps are being taken to secure an adequate water supply to afford fire protection. Mayor Newland is interested.

Spokane Falls, Wash.—The water supply is reported to be inadequate.

Portland, Ore.—The Highland Park Water Co. has been incorporated by A. E. Borthwick, Eugene D. White, E. E. Miller, G. E. Cankin and J. W. Going. Capital stock, $5,000.

Port Angeles, Cal.—The Port Angeles Water Co. has been formed with a capital stock of $200,000. J. R. Sawyer, of San Francisco, Cal., has been granted the franchise and expects to deliver water in October.

San Jacinto, Cal.—A reservoir, 3 miles in diameter, average depth 65 ft., is to be built by the Hemet Land and Water Co. Work will be commenced within 60 days.

Provo City, Utah.—We have received the following information:

The franchise has been given to Witcher Jones. Work will be commenced at once. The original plans were designed by Sturges & Bryant, of Salt Lake City, Utah.

Salt Lake City, Utah.—Bids will soon be wanted for lining the bottom of the Capitol Hill reservoir. Specifications are being prepared by City Engineer Doremus.

Nampa, Idaho.—The Nampa Water Co. has filed articles of incorporation. Capital stock, $100,000.

CANADA.

Montreal, P. Q.—The City Council has passed a resolution acknowledging Cote St. Paul's petition for a water supply agreeing to furnish water if the town will lay its own mains to the city limits. The Protestant Hospital for insane is to be supplied with water from the aqueduct, paying meter rates. The necessary meters will be purchased by the hospital.

Toronto, Ont.—A vote will be taken on August 6, on the question of issuing $200,000 of bonds for extensions, etc.

North Toronto, Ont.—A new reservoir is to be constructed, and contracts will probably soon be let. Mayor Fisher can furnish information.

Regina, N. W. Ter.—The Town Council will submit another by-law to the taxpayers for a vote on the question of expending $22,000 for a water supply and drainage system. A proposed plan for a water supply is to build a stone reservoir in Victoria Square, to be supplied by an artificial well.

FOREIGN.

Paris, France.—Prof. Senator Cornil is reported as stating that the present supply of spring water is inadequate, and that the two following plans have been projected for increasing it:

The first one is a system of canalization in each house. There would be a small pipe for the supply of spring water and a large pipe for river water for washing and cleansing purposes. This project would cost $20,000,000, and occupy 10 years for execution. The other plan is to filter the water taken from the Seine by means of sand. In the first plan Avre Springs, near Varneiul, 52 miles distant, is the proposed source of supply. A bill for the purchase of these springs is before Parliament. The maximum estimated daily supply from this source is about 34,000,000 galls. The total cost of carrying out the Avre Springs scheme, without the Seine River supply, is $7,000,000, and the yearly cost of maintenance is estimated at $10,000. The former sum would be drawn from $110,000,000 loan, which the city was authorized to make in 1886.

ARTESIAN WELLS.

Henrietta, Tex.—Bids are wanted for sinking a well.

Springfield, Dak.—A unanimous vote has been cast in favor of sinking a well.

IRRIGATION.

McCook, Neb.—E. H. Kellogg, of Denver, Col., Engineer in charge of the surveys for the McCook canal, has submitted his final report. The estimated total cost of the canal and reservoir is $250,000. The canal will be 70 mile in length, having a fall of 2 11-100 ft. to the mile.

Albuquerque, N. M.—Work on the canal of the Rio Grande Irrigation and Colonization Co. is to commenced this month. Chief Engineer Simpson states that the company expect to construct 200 miles of canals and establish a system of reservoirs. The capital stock is $5,000,000. P. R. Smith, of Boston, Mass., is one of the directors.

Phenix, Arizona.—The Farmer's Irrigation Co. has been incorporated by R. L. Hattersley, Walter Thompson and others. Capital stock, $100,000.

Idaho.—Surveys have been made in the Fayette country for a canal. A. C. Hammond, of Salt Lake City, Utah, has charge of the project. Estimated cost, $75,000.

SEWERAGE AND MUNICIPAL.

Paving has been ordered in the following cities: Montreal, P. Q.—Boston, Mass., granite block estimated at $15,000.—Rochester, N. Y., asphalt estimated at $16,000—Brooklyn, N. Y., cobble stone and Belgian block.—New York city, granite and asphalt.—Troy, N. Y., asphalt on concrete.—Newark, N. J.—Philadelphia, Pa., asphalt. Baltimore, Md.—Chattanooga, Tenn., asphalt costing $38,000.—Johnson City, Tenn., where $50,000 has been voted.—Columbus, O.—Cincinnati, O.—Port Huron, Mich., estimated expense $36,000.—St. Paul, Minn., cedar block costing $31,000.—Omaha, Neb.—Leavenworth, Kan., 2 miles of 40 ft. macadam road with terra cotta curbing.—Los Angeles, Cal., granite.

Sewers have been ordered in the following cities:—Montreal, P. Q.—Buffalo, N. Y., both pipe and brick.—Rochester, N. Y., stone sewer costing $42,000.—Troy, N. Y., 3,000 ft. brick sewers.—Attica, N. Y.—Brooklyn, N. Y.—New York City.—Newark, N. J.—Nashville, Tenn., trunk sewer costing $75,000.—Columbus, O.—Duluth, Minn.—St. Paul, Minn.—Omaha, Neb.—Leavenworth, Kan.

Bonds.—Waco, Tex., will issue $100,000 of street bonds.

Appropriations for streets and sewers of $200,000 in Newark, N. J., and $70,470 in Portland, Ore., have been proposed and will probably be made. New Bedford has voted $17,700 for similar work.

ELECTRICAL.

Electric Light.—Brooklyn, N. Y.—A franchise for lighting the eastern district has been granted to N. L. Cochen and M. L. Towns on condition that the fire and police wires be allowed on their poles or in their conduits; that they furnish free to the city 4 arc lights and 1 arc light for each 50 furnished private parties and 1 incandescent light for each 30 furnished private parties; and that the price per arc light of 2,000 c. p. shall never exceed 75 cts. or that of an incandescent lamp, 15 cts. per night.

New York, N. Y.—Bids for street lighting recently opened, averaged 35 cts. for each lamp per night until Jan. 1, 1891, afterward 44 cts.

Plants are proposed at Windsor, Ont.; Amsterdam, N. Y.; Millville, N. J.; Oakland and Laurel, Md.; Dawson, Ga.; Corinth, Miss.; Plaquemine and Patterson, Ga.; Louisville, Ky.; Trenton and Slater, Mo.; O'Neil, Neb.; Osage City, Kan.; Logan, Utah; Mt. Tabor, Ore.; Pasadena, Cal.

Extensions of existing plants are proposed at Pittsfield, Mass.; Covington, Ky.; Johnson City, Tex.

New Companies.—Franklin Electric Co., Berwick, Me.; capital stock, $200,000. N. H. Heard is interested.—Millersburg Electric Co., Millersburg, Vt.: C. E. Dustin is president.—Pittsfield, Mass., Electric Light Co.; capital stock, $100,000; President, Alex. Kennedy.—Wenstrom Electric Dynamo and Motor Co., Newark, N. J.; capital

stock, $500,000.—Florida Electric Co., Tampa, Fla.; capital stock, $50,000; incorporators, J. R. Ritter, S. Giglio and others.—Millersburg, O., Electric Co.; president, C. E. Dustin.—Archer Electric Light Co., Chicago, Ill.; capital stock, $15,000; incorporators, H. and P. Schmidt and C. F. Kroll.—Economy Light and Power Co., Chicago, Ill.; capital stock, $400,000; incorporators, W. A. McSurley, C. H. Briat and G. C. Helmer.—Fort Dearborn Light and Power Co., Chicago, Ill.; capital stock, $25,000; incorporators, A. L. Baker, E. F. Runyan and S. T. Parks.—Worrell Electric Construction Co., Chicago, Ill.; capital stock, $500,000; incorporators, C. E. Gaylord and others.—Parish Electric Light, Power and Heat Co., Nevada, Md.; capital stock, $120,000; incorporators, J. S. Brown, E. Parrish and S. A. Wright.—Seattle, Wash., Electric Light Co.; capital stock, $500,000; incorporators, J. H. McGraw, J. A. Williams and others.—Hamilton, Wash., Electric Light and Power Co.; capital stock, $50,000.

CONTRACTING.

Paving.—The German Rock Asphalt Co. of Buffalo, N. Y., lay their pavement at $2.85 a sq. yd. It is being now tried in Buffalo.

Baltimore, Md., has let a number of Belgian block repaving contracts at $2.40 per sq. yd.

At Memphis, Tenn., a recent contract was taken for furnishing gravel at 59½ cts. per cu. yd., grading at 25 cts. per cu. yd., and guttering at $1.69½ per cu. yd.

At Montreal, P. Q., recent bids for furnishing and laying tamarac blocks varied from $3.95 to $4.15 per sq. yd. A number of streets will be laid with Trinidad asphalt at $3.43 per sq. yd., and Sicilian asphalt at $3.97 per sq. yd.; the pavement to be guaranteed for 10 years.

Sewers.—Genesee, N. Y., has awarded a $16,000 contract to Green & McGregon, Buffalo, N. Y.

Passaic, N. J., has recently awarded a contract to McKiernen & Bergen at the following prices: 20 in. pipe, $1.42; 18 in., $1.21; 15 in., 82c.; 12 in., 71c.; 10 in., 59c.; 8 in., 49c; 6 in., 41c.; manholes, $40 each; flush tanks, $75 each; masonry, $4.50 per cu. yd.; iron pipe, per ton, $40; concrete, $7 per cu. yd.; piling 50c. per lin. ft.; M. timber, $20; rock, $1.50 per cu. yd.; large flush tank, $500.

St. Paul, Minn., has contracted with Kirkland & Starkey for a sewer to cost $53,243. The bids ranged from that figure to $71,900.

Granite Paving Blocks.—Norfolk, Va., has received the following bids for 3,000 tons of second-class blocks: Greystone Granite & Construction Co., Greystone, N. C., $3.85 per ton; P. Linehan, Raleigh, N. C., $3.94; Winnsboro Granite Co., Charleston, S. C., $7.15. The Greystone Co. were the successful bidders.

Water Pipe and Hydrants.—Sioux City, Ia., has received bids for furnishing and laying water pipe and hydrants as follows: 8-in. pipe, $42.90 per ton; 6-in., $45.55; 4-in., $52.85; 8-in. valves, $33 each; 6-in. valves, $28; 4-in. valves, $20; double-valve hydrants, $50.

Dredging at the Brooklyn Navy Yard. The following bids were received: N. S. Beard, Brooklyn, $20,700, accepted; P. S. Ross, Jersey City, N. J., $23,850; Atlantic Dredging Co., New York, $21,600.

Canal Work.—The following bids have been received by E. H. Hannon, Albany, N. Y.: For lengthening canal locks: Lock 40, Erie Canal, Hughes Bros., Syracuse, $31,486.75; Lock 41, Erie, Hughes Bros., $29,422.05; Lock 46, Erie, Hughes Bros., $22,390.25; Lock 12, Oswego Canal, Hughes Bros., $37,245.70; Lock 1, Black River Canal, Hughes Bros., $7,881; Lock 42, Erie, Casey, Murray & Co., Elmira, $32,415.80; Lock 43, Erie, Casey, Murray & Co., $31,377.50; Lock 8, Oswego Canal, William Patrick, Phœnix, $31 731.70.

The Busk Tunnel contract has not yet been awarded, D. Shanahan & Co. having withdrawn the bids. Further details will be found in our news columns.

PROPOSALS OPEN.

Paving.—Granite block on concrete; T. F. Gilroy, New York City. July 24.—Medina and brick; City Surveyor, Rochester, N. Y. July 21.—Asphalt, brick and cement; J. W. Douglass, Washington, D. C. July 29.—Hamilton County Commissioners, Cincinnati, O. July 23.—Medina stone with concrete filling; Columbus, O. July 24.—Trinidad asphalt blocks; Southern Pavement Co., Fort Payne, Ala.—6,000 sq. yds. of brick on concrete; Street Commissioners, Pine Bluff, Ark.—J. M. Edson, New Whatcom, Wash., 9,800 sq. yds., either granite block, natural face No. 1 sandstone, Trinidad or Sicilian asphalt, all on concrete foundation, with new curbing, crosswalks (with stone pavement) and catch-basins; estimated cost, $40,000 to $50,000. 16,670 sq. yds. Trinidad or Sicilian rock pavement. H. W. Clarke, City Engineer, Syracuse, N. Y. July 28.

Paving and Arch Brick.—J. W. Douglass, Washington, D. C. July 29.

Grading.—Contracting Board, Troy, N. Y. July 22.

Sewers.—2,100 lin. ft. excavation and fill; 1,475 cu. yds. brick masonry, American cement; 550 cu. yds. brick masonry, Portland cement; 8,450 cu. yds. concrete masonry; W. Jackson, Boston, Mass. July 24.—9,000 ft. pipe sewer; C. W. Conant, Gardner, Mass. July 23.—A. L. Lincoln, Jr., Brookline, Mass. July 21.—1,050 ft. 10-in. vitrified pipe, 7,290 ft. 8-in., 1,750 ft. 6-in., 4,800 ft. 4-in., 26 manholes; City Clerk, Gloversville, N. Y. July 21.—E. O. Ross, Troy, N. Y. July 22.—24, 20, 18, and 15-in. pipe; E. M. Bigelow, Pittsburg, Pa. July 17.—Complete system; City Clerk, Key West, Fla. Sept. 1.—C. G. Force, Cleveland, O. July 24.—2,000 ft. pipe; J. B. Weddell, Galion, O.—City Clerk, Fremont, O. July 22. 960 ft. 48-in. brick sewer; 180 ft. 48-in. brick with piling; 1,420 ft. 42-in. brick; 340 ft. 42-in. brick on piling; 110 ft. 36-in. brick on piling; 480 ft. 36-in. brick; 330 ft. 30-in. brick; 930 ft. 24-in. brick; 426 ft. 18-in. pipe; 1,844 ft. 15-in. pipe; 2,140 ft. 12-in. pipe; 710 ft. 10-in. culvert; 35 catch basins; 53 manholes. A. B. Hill, New Haven, Conn. July 23.

Fish Ways.—Ed. Hannon, Albany, N. Y. July 22.

Removing Wreck of steamer Mediator at Barnegat Inlet, N. J. Maj. C. W. Raymond, 1428 Arch St., Philadelphia, Pa. Aug. 11.

Stone Bridge—Segmental arch, 158 ft. span, 28 ft. rise, 4.5 ft. depth of key, 6 ft. depth of springers, width 47 ft. F. L. Hoge, Wheeling, W. Va. July 21.

Stone Crusher.—Town Clerk, Wappingers Falls, N. Y.

Heating Plant.—At the Army Gun Factory. Lieut.-Col. F. H. Parker, Watervliet Arsenal, Troy, N. Y. Aug. 7.

Foundation Work for U. S. custom house and post-office at New Bedford, Mass. J. H. Windrim, Washington, D. C. July 29.

Buildings.—County jail. Board of Commissioners, Wheeling, W. Va.—Hospital for Ohio State University. A. Cope, Columbus, O. Aug. 5.

Dredging.—87,000 cu. yds. Dock Commissioners, New York City. July 23.—197,000 cu. yds., partly rock. E. Hannon, Albany, N. Y. July 22.

Pier.—Repairing. Dock Commissioners, New York City. July 23.

Rip-Rap.—Furnishing and laying. Dock Commissioners, New York City. July 31.

Water-Works.—All labor and material required. Water Commissioners, Watkins, N. Y. July 23.—Four miles canal work, masonry, dams, headgates, etc. H. Q. Sanderson, Springfield, Mass. July 24

Laying Water Mains.—T. J. Neville, Rochester, N. Y. July 21.—T. H. Gilroy, New York City. July 24.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Schenectady Works are compelled to refuse orders for engines to be finished within a year. Full night and day gangs are working.

The Jacksonville Southern R. R. has received 2 locomotives from the Rhode Island Works.

The Louisville, New Albany & Chicago Ry. has received 4 engines from the Baldwin Works, and expect 6 more.

The Dickson Co., of Scranton, Pa., are working on 25 engines for the New York, Ontario& Western Ry.

The Brooks Locomotive Works have received an order for 25 locomotives for the Illinois Central R. R.

Cars.—The Atchison, Topeka & Santa Fé R. R. has contracted with the Wells & French Co. for 1,000 box cars, and with the St. Charles Co., of St. Louis, Mo., for 400.

The Indianapolis Car Works built 645 new cars in June. The foundry turned out 2,150 wheels a day.

The Louisville, New Orleans & Texas Ry. has ordered 400 freight cars of the Missouri Car & Foundry Co.

The Denver & Rio Grande R. R. has ordered 1,000 freight cars and 65 passenger cars for the standard gauge line.

The cars to be built by the Steel Tubular Car Co. at their works near Bradford, Pa., will be constructed with a framework of hollow steel tubes, so put together that they will be able to stand any shock or strain that cars are liable to meet in cases of collision.

The St. Charles Car Works of St. Louis have turned out a handsome private car for the president of the Mexican Central Ry. It cost $20,000.

The U. S. Rolling Stock Co. is working on 50 flat and 10 box cars for the Duluth & Winnipeg Ry.

The Toledo & Ohio Central R. R. is having 100 box cars built at the Ohio Falls Car Works.

The Haardegen Water Indicator.—This device, the working tests of which we have previously described in these columns, and through which it is claimed that subterranean streams of water can be located, is being quite extensively tried, and we are told with notable success. Some recent instances are recorded in our advertising columns elsewhere. While a claim to such powers is looked on with natural skepticism, in which we certainly share, yet anything of the kind which has reached the stage that water is guaranteed as predicted or no charge is made for the well, is certainly entitled to a good measure of respect as long as its record continues good.

Electric Railway Poles are a specialty of the Walworth Mfg. Co., of Boston, Mass. They are usually 32 ft. long and made of 4, 5 and 6 in. pipe.

The Lidgerwood Mfg. Co., of Chicago, Boston and New York has opened a branch house at Portland, Ore.

Wm. Cramp & Sons have bought 60 acres of land near Philadelphia on the Delaware River, and will build a new shipyard there.

Two New Depots will be built at Kansas City, Mo., by the Kansas City Suburban & Belt Ry. Co. One, a passenger depot, will be of pressed brick, 77 by 189 ft., and the other is a plain freight house, 300 by 70 ft.

The Westinghouse Electric & Mfg. Co. has already received orders for electric motors from 17 street railways although it has but recently entered this field. Their motor has proved a great success on the Pleasant Valley line in Allegheny City, Pa.

The Steel Tubular Car Works to be erected at Bradford have been designed by J. S. Briean, of Philadelphia, Pa. The main building, of stone and brick, is E-shaped with 3 fronts of 644 ft. and 2 of 580 ft. There will be 20 finishing buildings, 40 by 200 ft.; a boiler house, 53 by 196 ft.; a dynamo house, 60 by 200 ft.; a blacksmith shop, 76 by 207 ft.; a foundry, 160 by 226 ft., 3 engine houses, 24 by 45 ft., and an office building 50 by 208 ft. The company hope to have their plant finished within 18 months.

Ship-Building on the Great Lakes.—F. W. Wheeler, of Bay City, Mich., is employing 1,300 men. He has 14 vessels, valued at $1,720,000, on the ways. J. M. Davidson, of the same city, has 9 vessels under construction and employs 600 hands. The Detroit Dry Dock Co. is finishing the last of 6 vessels for the Vermont Central line. The "Maryland," now under construction for the Inter-Ocean Transportation Co., will be the largest freight steamer on the Lakes, have a capacity of 3,500 tons. The Craig Shipbuilding Co., of Toledo, O., has completed its yards, and are at work on its first steel ship. The Cleveland (O.) Shipbuilding Co. is constructing 2 large steel steamers for the iron trade, and there are at least a half dozen other steamers on the ways in other yards of that city. The Union Dry Dock Co., of Buffalo, N. Y., is building 2 steel steamers, and Alex. McDougall, of the same city, is employing 1,000 hands in his yards. The Chicago Shipbuilding Co. is at work on 2 steel steamers for the iron trade.

The Nashua (N. H.) Iron & Steel Co. is making 14 propeller shafts and the forgings for 14 crank shafts for the U. S. Navy.

The Westinghouse Machine Co. sold 79 engines, aggregating 5,005 h. p., during May. A number of these went to France and Germany and a 75 h. p. engine to Brazil.

The Martin Anti-Fire Car Heating Co., of Dunkirk, N. Y., has added a 40 × 80 ft. pattern shop to its plant.

The Blake Mfg. Co. has sold out to an English syndicate for $3,000,000.

The Babcock & Wilcox Co. will furnish additional boilers of 1,120 H. P. to the Narragansett Electric Light Co., Providence, R. I., and change the present Moore boilers into the Babcock & Wilcox system.

The Ries Electric Traction & Brake Co. has been incorporated at Baltimore, Md., for manufacturing the apparatus invented by E. E. Ries for increasing traction electrically. The capital stock is $2,000,000.

New Companies.—Standard Gas & Electric Light Co., Huntington, Mass.; capital stock, $200,000; incorporators, A. D. Palmer, E. F. Ayrault, C. A. Teare.—Empire City Subway Co., New York City; capital stock, $300,000; incorporators, W. T. Bouchelle, H. F. Stevens and others.—Eastern Steel Co., Camden, N. J.; capital stock, $100,000; incorporators, S. C. Rockman, H. C. Terry, M. D. Johnston, of Philadelphia.—National Electric Ice Machine Co., Chicago, Ill.; capital, $1,000,000; incorporators, F. K. Beggs, W. M. McEwen, G. E. Walter.—Railway Equipment Co., Chicago, Ill.; capital stock, $250,000; incorporators, J. Veeder, O. R. Barnett, P. R. Shumway.—Universal Electric Construction Co., Chicago, Ill.; capital stock, $500,000; incorporators, C. M. Pealey, E. Brainard, F. H. Wood.

Metal Market Prices.—*Rails*—New York: $31 to $31.50; old rails, $24 to $24..50 for iron, $19 to $19.50 for steel. Chicago: $34 to $35; old rails, $23.50 to $26.60 for iron, $21.50 to $22 for steel. Pittsburg: $31 to $32; old rails, $26.20 to $26 for iron; $21 to $21.50 for steel.

Foundry Pig-iron.—Chicago: $14 to $17. Pittsburg, $14.50 to $17.50. New York: $16 to $18.50.

Track Materials.—New York: fish plates, 1.75 to 1.9 cts.; spikes, $2 to $2.05; track bolts, 2.8 to 3 cts. with square nuts. Pittsburg: splice bars, 1.80 to 1.90 cts. for iron; spikes 2.05 to 2.15 cts. delivered at Chicago or St. Louis; track bolts, 2.85 to $2.90 cts. with square, and 2.95 to 3 cts. with hexagon nuts. Chicago: splice bars, 2.25 cts. for steel, and 2 to 2.05 cts. for iron; spikes, $2; track bolts, 3 cts., with hexagon nuts.

Pipe.—Cast-iron, about $27 to $30 per ton, according to competition and amount of order. Wrought iron, discounts as follows: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—Chicago, 4.4 to 4.45 cts.

Structural Material.—Pittsburg: angles, 2.15 to 2.2 cts.; tees, 2.75 cts.; beams and channels, 3.10 cts.; sheared steel bridge plates, 2.65 to 2.75 cts.; universal mill plates, 2.3 cts.; refined bars, 1.90 to 2 cts.; steel plates, 4.25 to 4.75 cts. for fire box; 3.15 to 3.20 cts. for flange; 3 cts. for shell, 2.75 cts. for tank. Chicago: angle, 2.2 to 2.25 cts.; tees, 2.5 to 2.65 cts.; beams, 3.2 cts.; universal plates, 2.45 to 2.55 cts. New York: plates, 2.15 to 2.20 cts.; angles, 2.2 to 2.25 cts.; tees, 2.5 to 2.6 cts.; beams and channels, 3.1 cts.